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Report
on a
Mining Concession
in the
Egyptian Sudan.

BY
ARTHUR LLEWELLYN.

AUGUST, 1903.

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No. 22. 4

EGYPT & SUDAN MINING SYNDICATE, LIMITED.

LONDON, 31*st* *July*, 1903.

MESSRS. JOHN TAYLOR & SONS,
Managers,
EGYPT & SUDAN MINING SYNDICATE, LIMITED,
6, Queen Street Place, London, E.C.

GENTLEMEN,

Herewith I have the honour to submit to you my final Report on your Mining Concession in the Egyptian Sudan.

The expedition, comprising four Europeans, arrived on the Concession at the end of October 1901, and was joined by two additional Europeans in March 1902. Work in the field has occupied two working seasons, lasting from November to May—a total of fourteen months, while work at the Om Nabardi mines since its inception in November 1901 has proceeded without intermission. Work at the Nabi mines was commenced in May 1902, and continued to the end of May 1903.

The Wells of Murat being centrally situated in the Concession and having a never failing supply of water, this spot was selected as the headquarters of the expedition, and exploratory marches thence into the surrounding country were planned with due regard to the position of reputed auriferous localities and connection with other wells. The longest of such marches extended over a period of 27 days and a distance of 360 miles. Camels were the only means of transport available or suitable, and as a baggage camel covers only 20 to 25 miles a day progress was necessarily slow. The ordinary speed of a baggage camel is 2½ miles an hour, and that of a riding camel 4 to 5 miles; but the expedition being dependent on the former for food and water, the rate of progress was governed by the slower pace.

During the marches the expedition was under the protection of Abdul Azim Bey, Khalifa of Berber, whose representative invariably accompanied us, and to whom we are indebted for much friendly assistance and advice. Route surveys and topographical records were kept of all marches, and from these a map of the Concession will be prepared, shewing the principal topographical features and the positions of

Equipment Caravan starting from No. 6 Station.

Grain Caravan en route [illegible]bu Hamed to Murat.

uriferous areas. But little time was available for close geological observation while on he march, such investigation as was possible being confined almost entirely to the ocalities of ancient mines and the halts at various wells.

Previous to the present enquiry but little was known to Europeans of the ountry covered by this Concession, and no modern mining work had been attempted n the Sudan. Such localities as were reputed to contain ancient mining works have een carefully examined, and many other mining areas have been discovered which were not previously known to exist. In such a huge Concession it is not supposed that every ancient mine has been discovered, or that those which have been found include *all* the most important; but it is, I think, a reasonable assumption that they are, at least, a fair ensample of the whole, and that no larger mines will be found to exist than the largest which are here described.

This view is strengthened by the collated opinions of the Desert Arabs who, while extremely apathetic as regards the mines themselves, are fairly well agreed as to their relative size and importance. Some of the mines, however, appear to be unknown even to the Arabs, who rarely leave the beaten track from well to well unless in search of a straying camel. These men—mostly nomadic Bisharin—were always courteous and well disposed, giving readily such information as they possessed, which in the matter of roads was always reliable. They are, however, too few and far between to be of much use to the explorer, and it often happened that the expedition would be a fortnight on the march without meeting a single individual.

It may, I think, be fairly said that the object of the expedition has been accomplished. Once and for all the question has been settled as to the real auriferousness of these Sudan fields. The ancient mines have been found, many of them have been re-opened, and samples have been taken from the reefs. Some of the most easily accessible of the Mines have been selected for deeper trial and are now in active work. There remains no doubt that there was a very extensive gold mining industry here in the past, and it is equally certain that there remains a huge gold-field here to-day; for the workings of the ancients, extensive as they certainly are, can only be considered as the merest scratchings on the outcrop of the reefs.

Whether or not these reefs can be profitably worked under modern conditions is a problem which can only be solved by practical experiment. No consideration of the magnitude of the ancient work, or the marvellous traditions of its productiveness can assist us in forming an opinion. The value of gold was the measure of its demand, and if gold were required it had to be obtained, whatever the cost or whatever the sacrifice of human life. To-day the principal factors to be considered are the cost of labour, transport, and material, and these can be but approximately estimated, while the dominating factor—the value per fathom of the reef—cannot even be guessed until the reef is opened up and developed to a reasonable depth.

Such development is now proceeding and, as will be seen in this Report, is attended with very satisfactory results indeed. Assays of 2 to 3 ounces of gold per ton for the whole breadth of the reef at Om Nabardi are of common occurrence, and

The reefs are strong and well-defined,

and there is every indication of their continuance in depth. The works as yet are comparatively shallow—from 100 to 150 feet below surface,—and as the ancients have at places gone deeper than this it is probable that the values given above do not represent the richest portions of the reefs. Should the development now in progress at Om Nabardi continue in this satisfactory manner, and the reef in depth fulfil the promise of its present appearance, there is little doubt that, adverse as the conditions undoubtedly are, the mine can be made a paying proposition.

These conditions, as work progresses, will tend naturally towards amelioration. Improved railway communication will lessen the cost of transport, when the cost of living and of labour will be correspondingly reduced. With better housing the irksomeness of the summer season to resident Europeans will be much relieved. Development of the natural resources of the country further south will result in an indigenous timber supply, and possibly in the discovery of coal. It is believed that as depth is attained the mines will themselves produce a sufficient water supply for their exploitation, while for milling requirements a supply can be pumped from the Nile at a cost well within the means of a moderately productive mine; or failing this the ore can be transported to the river at a cost of less than ten shillings per ton.

I cannot conclude this Report without a well-earned word of praise for my assistants. The mining work at Om-Nabardi has been under the charge of Messrs. W. E. Argall and H. Perry-Keene, and the excellent progress attained with the present crude appliances and unskilled labour testifies to their industry and resourcefulness. The operations at Nabi and Nahi Tana have been conducted by Messrs. W. D. Hole and J. M. Tharp in an energetic and intelligent manner, and the amount of useful work accomplished in face of the trying climatic conditions and distance from the sources of supply reflects great credit on their perseverance and ability. To them and to the other members of the staff I am indebted for their allegiance and ever ready help, without which the success of the expedition would have been impossible.

I desire also to record my appreciation of the attitude of the Sudan Government towards your enterprise. It has assisted the expedition in every way in which assistance was required, and our dealings with the officials have always been marked by courtesy and good feeling. To Colonel Talbot, the Director of Surveys, the expedition is particularly indebted for much useful help and for the friendly interest displayed. Mr. W. Jennings-Bramley also rendered us valuable assistance in our dealings with the local tribes, while to the Administrator of the Halfa District, Capt. Hayes-Sadler, we are much indebted for his general support as the local representative of Government.

I have the honour to be, Gentlemen,

Your obedient servant,

ARTHUR LLEWELLYN.

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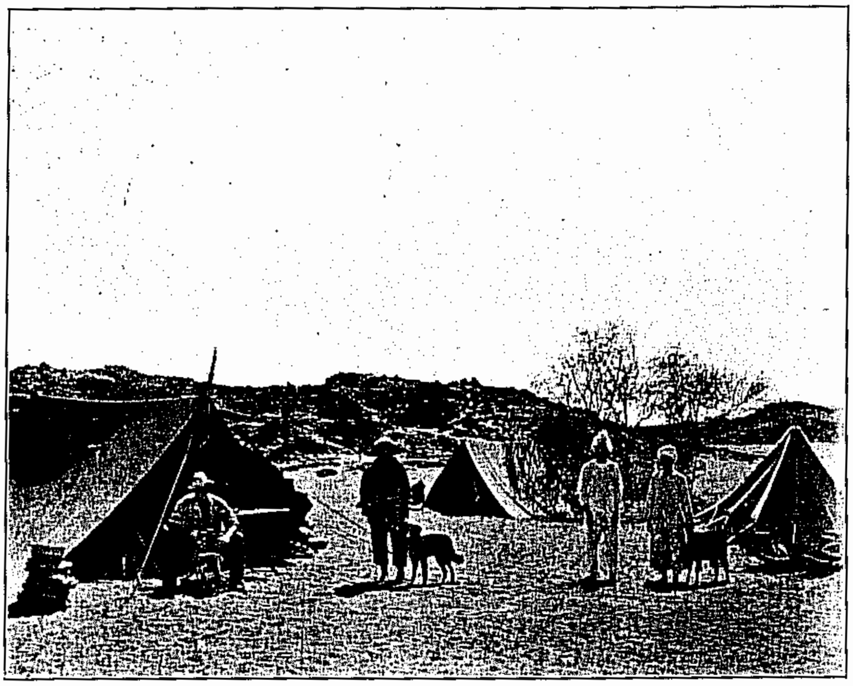
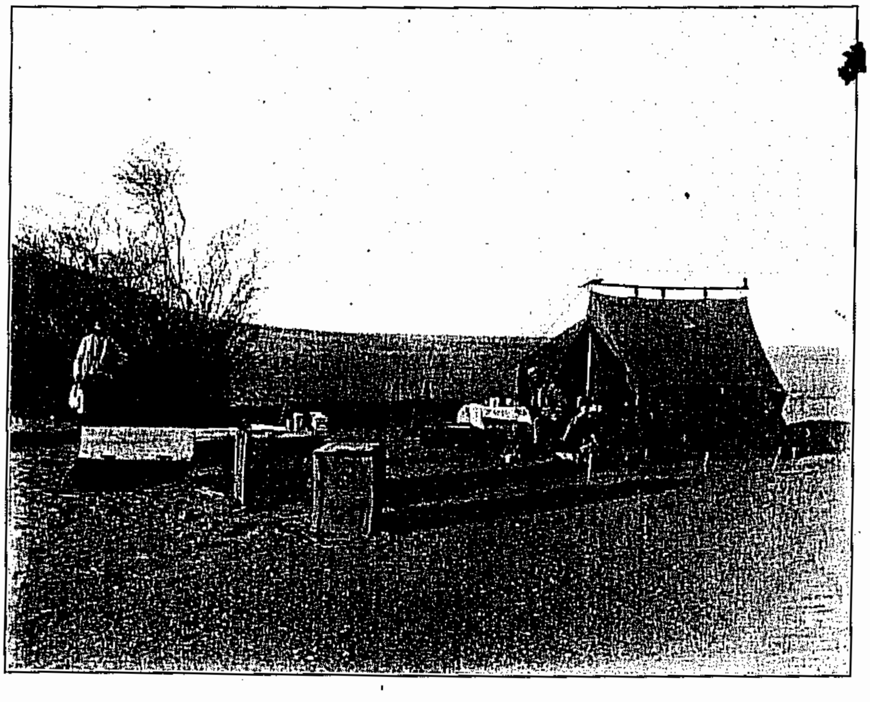
I.



Prospector's Camp.



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REPORT

ON A

MINING CONCESSION IN THE EGYPTIAN SUDAN.

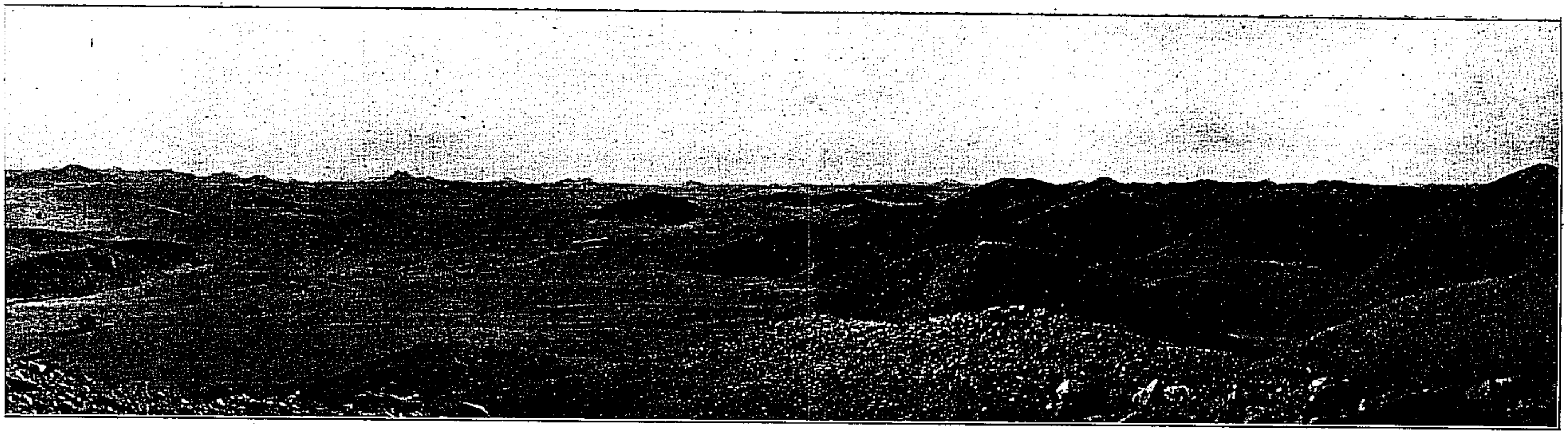
PART I.

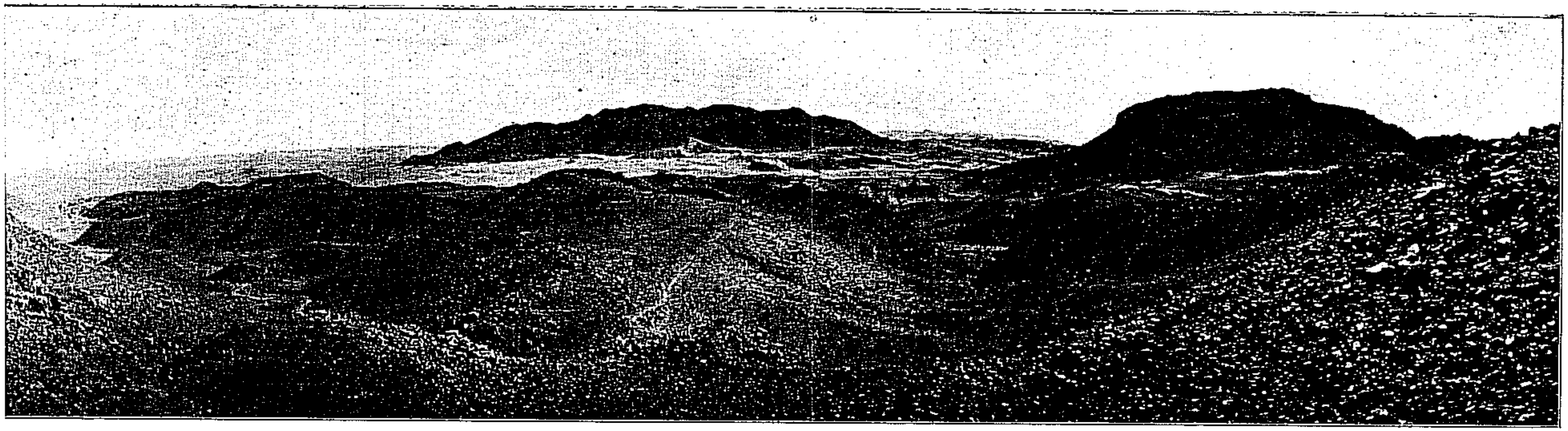
GEOGRAPHICAL.

Position.—The Concession is situated in the Egyptian Sudan, between the Nile and the Red Sea, and within the limits of ancient Nubia. This region is also known as the Central Etbai, the name Etbai being applied to the country between the river and the sea, from the borders of Lower Egypt to the confines of Abyssinia. The Concession extends from the 20th to the 22nd parallel of latitude north, and from longtitude 32° to 34° 30′ east of Greenwich.

Area and Boundaries.—The area is approximately 22,000 square miles, and the north-western corner of the Concession is within 15 miles of the Nile at Adda, while the eastern boundary is 150 miles from the Red Sea coast. The Nile approaches to within 32 miles of the southern boundary at Abu Hamed, whence it falls back at a sharp angle and passes down 90 miles west of the south-western corner. The northern boundary is conterminous with the northern boundary of the Sudan.

Topography.—The country is entirely desert, but unlike the desert tracts west of the Nile, which alternate between stony plain and a billowy sea of sand, the eastern desert is varied and picturesque, some of the hills reaching an altitude of 6,000 feet. The main range forms a barrier roughly parallel with the Red Sea coast, and from this broad spurs extend westward which gradually break up into smaller ranges and isolated hills separated by increasing areas of undulating plain. The drainage is chiefly westward to the Nile and is effected by broad sandy torrent beds locally known as *wadies*.





Typical Views of Mountainous Desert.

These wadies, though mostly arid and bare, correspond to what in a well watered country would be the stream and river courses, with their accompanying strips of fertile alluvium. They are an important feature of the desert, for they form the main highways of communication, and such scanty vegetation as the country affords is confined to their narrow limits. In their sandy beds the Arab makes his ever-changing home ; the wells and water holes on which he relies to supply his family and his flocks are in the wadies ; and to them the life and movement of the desert, such as it is, is practically confined.

The chief wady in this Concession is the Gabgabha. Rising somewhere east of Abu Hamed it crosses the southern boundary at about its mid-length and traverses the Concession in a direction slightly west of north, receiving on its way the drainage of numerous tributary wadies from east and west, some of which have a length of over 100 miles. 25 miles north of the Concession it enters the Wady Allagi, which in turn, after a further course of 60 miles, enters the Nile at a point 40 miles below Korosko. The drainage of the Concession is therefore from the east and west towards the centre. At the north-east corner the Uffain-Machuchenaye range forms the line of watershed, while from the north-western corner a watershed line extends south through Jebel Mundera, diverting the rainfall on that side directly to the Nile.

The surface in the southern and western portions of the Concession is an undulating sandy plain with isolated hills and widely separated ranges. Towards the east the hills rapidly close up and the eastern and north-eastern portions are entirely mountainous. The elevation of the plain varies from 600 to 1,600 feet above mean sea level, and many of the hills rise 1,000 feet above the plain. The chief hill range is Jebel Ṛafit, which covers an area of about 150 square miles and reaches an altitude of 2,500 feet. It is important as attracting the greatest rainfall of the district, and also because of the numerous water holes or *mahzans* in its deeply cut ravines. Another high and important range is the Uffain-Butna range in the north-eastern corner of the Concession. It also is said to receive a certain annual rainfall, although the steep, regular contours afford no means of natural storage.

The hills are stony and bare, without either soil or vegetation. They afford an ideal field of study for the field geologist, who is soon able to distinguish from afar the pinnacled crags of granite or diorite ; the dome-shaped hills of finer trap ; the serrated ridges of quartzite ; the cornice-like escarpments of sandstone ; the ragged, irregular hills of schist ; the mammillary forms of softer shale ; and the gleaming white and blue of limestone rocks.

Climate.—The year may be divided equally into two seasons : the cool season, lasting from November to April, and the hot season, from May to October. The former is delightful and cannot well be surpassed in any part of the world ; but the hot season, though not unhealthy, is far from agreeable on account of the continuous high temperature and frequent dust storms.

From the accompanying chart it will be seen that the mean temperature in the cold weather is 72° F., while the mean temperature in summer is 92° F.

Compared with Europe these figures will appear high ; but the atmosphere of the desert being remarkably dry, the high temperatures are not nearly so oppressive as they would otherwise be. This condition also renders it extremely healthy, and malaria is practically unknown, while colds and lung complaints are very rare. Practically the only diseases to be feared are sunstroke and dysentery, and these are more often than not the result of carelessness in exposing the person insufficiently covered to the direct rays of the sun, or to the cold, high winds.

TEMPERATURE RECORD, 1901-1903.

	MURAT, Deg. F.*					NABI, Deg. F.				
	Average Max.	Average Min.	Mean.	Highest.	Lowest.	Average Max.	Average Min.	Mean.	Highest.	Lowest.
1901.										
November ...	86·0	67·5	76·7	98·0	54·0					
December ...	74·5	56·4	65·0	88·0	44·0					
1902.										
January ...	67·3	51·0	59·1	84·0	42·0					
February ...	80·3	69·4	74·8	88·0	55·0					
March ...	88·4	68·5	78·4	96·0	60·0					
April ...	90·0	78·2	84·1	100·0	67·0					
May ...	105·8	83·8	94·8	112·0	76·0	111·3	85·0	98·1	120·0	78·0
June ...	103·1	83·6	93·3	108·0	80·0	109·5	86·0	97·8	114·0	78·0
July ...	100·0	84·5	92·2	103·0	82·0	105·0	83·0	94·0	109·0	79·0
August ...	102·7	86·0	94·3	106·0	82·0	107·0	84·5	93·8	115·0	78·0
September ...	100·0	85·0	92·5	103·0	80·0	105·0	84·0	94·5	110·0	76·0
October ...	94·0	83·0	88·5	100·0	78·0	98·0	77·0	87·5	106·0	67·0
November ...	82·2	68·7	75·5	92·0	60·0	87·0	65·0	76·0	100·0	57·0
December ...	77·3	52·6	65·0	86·0	40·0	80·6	56·0	68·3	86·0	44·0
1903.										
January ...	74·6	51·1	62·8	86·0	30·0	70·8	52·4	61·6	86·0	44·0
February ...	78·5	53·9	66·2	90·0	47·0	76·5	55·5	66·0	84·0	46·0
March ...	85·5	58·7	72·1	98·0	50·0	84·8	66·2	75·5	94·0	56·0
April ...	98·7	69·3	84·0	105·0	55·0	100·5	81·0	90·7	111·0	68·0
May ...	101·1	79·6	90·3	112·0	68·0	106·2	85·0	95·6	115·0	78·0

* Temperatures under this head were observed not only at Murat but at various points throughout the Concession. Among hills, as at Murat the temperature at the hill top is usually 5° to 6° lower maximum, and 5° to 6° higher minimum, the mean being unaffected.

The rainfall is slight and irregular. In the most favoured part of the Concession, Jebel Rafit, it is said by the Arabs that rain falls every year, and this appears to be the case. In some other parts of the Concession rain is practically unknown except at intervals of several years. It will thus be seen that the showers are very local. They are, however, often extremely heavy, and after a few hours rain in the hills the largest wadies "come down" in flood, carrying all before them until the stream gradually disappears into the sandy plain. During the period of this examination it has rained on Rafit hills as follows :—

1901, Oct. 10. Good fall of some hours, mainly on east side.
,, Nov. 19. Slight showers towards middle of range.
1902, Oct. 12. Rain all night, mainly on west side.
1903, Feb. 17. Slight showers, principally on north side.
,, May 8.} Heavy rains lasting three hours each day on north side and
,, ,, 9.} west of Tonaidba.

These falls were not gauged, but at Murat, where there is a rain gauge, the amount collected on 19th November 1901 was three cents., and on May 8th 1903 eight cents. The showers at Murat were light, for although it is but ten miles from Jebel Rafit, rain at Murat is very rare indeed, the last time the wady came down being in 1891.

There is nearly always a breeze blowing across this portion of the desert, sometimes a good deal stronger than is agreeable. During the cold season the prevailing direction is from north and north-east, while in the hot weather it blows from the south and south-west, from which direction come also the stifling, hot, sand-laden winds of the *Khamsin*, the sun being often obscured thereby for days.

People.—The present inhabitants of this part of the Sudan are known as the Bega Bedouins, and are considered by Dr. Lepsius to be the descendants of the ancient Blemmyes. The Bega consist of three races—the *Hadendowa*, the *Bisharin*, and the *Ababdi*; but the former being confined to a region altogether south of this Concession will not require further notice here. Of the Bisharin and Ababdi, the latter are the more advanced, occupying themselves in some measure with the arts of civilization, while the Bisharin retain their nomadic instincts to the full and devote themselves to the rearing of sheep and goats and camels, wandering in a half naked condition over the desert in search of such scanty pasturage as it affords. They are a small and slender people, but symmetrical and well featured, and their colour is usually a rich dark bronze. Most of them wear their hair in a corkscrewed cloud on top with a fringe of plaits over the neck and shoulders, which gives them a warlike aspect altogether out of keeping with their peaceful habits. They subsist chiefly on the milk produced by their flocks, with occasionally a little meat either of a kid or such small game as they are fortunate enough to capture in the desert. Their houses consist of a few palm-leaf mats stretched on sticks, and their domestic belongings are of the most meagre description. They are courteous in their behaviour to travellers, but haughty and independent, and seem best pleased when left to themselves and to their own simple ways.

The Ababdi are a more sociable people, and although still somewhat nomadic in their habits, they frequently settle in villages along the river side, where they build themselves houses of stone and mud, the desert dwellers among them being chiefly the herdsmen of those who live in the greater comfort of the villages. They are a handsome, dashing race, courteous enough to strangers, but truculent and crafty in their dealings, and, like most Arabs, too much inclined to think themselves the chosen people of the earth. It is considered by some writers that these people are the direct descendants of the *Troglodytes* or "Cave-dwellers" of the ancient writers, although Floyer* is of opinion that they are strangers who by their own account came from the south. In the absence of natural caves in this country, unless we accept the overhanging cliffs of Nubian sandstone as such, it is difficult to see how the name could have arisen unless applied to the workers in the ancient mines, which the Ababdi, who are purely a pastoral race, could scarcely have been. Although nominally the Bisharin are under the jurisdiction of the chief sheik of the Ababdi, there is no

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* Journal Royal Asiatic Society 1892.

PLATE IV.

LOADING UP GRAIN CARAVAN ABU HAMED.

DESERT ARABS AT MURAT WELLS.

merging of the races or of their interests, each people clinging tenaciously to its grazing grounds and to the entire possession of its wells. Not only are these rights recognized and observed by the two races, but the various tribes into which each is divided respect each other's particular claims thereto and rarely encroach unless with the other's permission and approval. Serious quarrels sometimes result from an infringement of this rule, and tribal feuds are not unknown; but since the British occupation there is rarely a recourse to arms, the services of some friendly sheik being called into requisition to settle the dispute.

There may be a hard and fast line between the areas claimed by Bisharin and Ababdi within this Concession; if so, it is known only to themselves, but judging from recognized ownership of wells and water-holes, such a line, if it exists, would seem to run roughly north and south at about the 33rd meridian.

Fauna.—As might be expected, animal life in the desert is very limited, in numbers as well as in variety. The Arabs have a proverb that the camel drove the lion out of Palestine, and in a similar manner he is slowly but surely driving all before him here; for no other ruminant can live where a camel fails to find his food; and with the ruminants go the beasts of prey. Chief among four-footed game is the Kebsh or mountain sheep, a few of which still remain at Jebel Rafit and at Shigre. Gazelle are more numerous, and are to be found in most of the wadies where the vegetation is fresh and green. They are exceedingly timid and shy, but the Arab although a poor sportsman, manages to keep them down, chiefly by snares and by clubbing the young as they rest in the shade. Foxes (a small grey variety) are more numerous than might be expected; although rarely seen their cry is common enough at night, and their spoor is found in every camp. Hares are sometimes seen, but are not common. Conies are found in the hills at Abu Siha and Rafit, but are comparatively rare. Of Rats, a small variety is very common in the wady beds, where it lives on the roots of herbs and grass, burrowing thereafter until the whole surface is undermined.

Of Birds, the Vulture (*Nubicus*) is common, as also is the Kite. Ravens are frequently seen, a pair usually taking up their abode in the neighbourhood of every open well. The Crow and the Sparrow are remarkable by their absence; but the Wagtail is found at the wells, as is also a small dun-coloured bird which is probably a Warbler. Periodically the common Heron comes up from the Nile in huge flights, but is rarely seen to alight. Of game birds the only varieties seen were the Sand-grouse and the Quail, also a small Partridge; and these are confined to the neighbourhood of the more open wells. It is said by the Arabs that thirty years ago the Ostrich was common in these parts, but he is rarely seen north of Suakin to-day. Now and again footprints have been noticed in the bed of the Gabgabba, and the broken shells of ostrich eggs are found all over the Concession. The latter, however, being extremely durable, are useless as evidence regarding time.

Flora.—The vegetation of the country is confined to the wady beds, many of which after even a scanty rainfall produce a growth of herbage and coarse grass which affords excellent grazing for sheep and camels. The larger wadies often carry an abundant growth of a low, running plant, the name of which is not known, but which unfortunately is useless for grazing purposes. It produces a fruit somewhat resembling a small melon in appearance, but intensely bitter and unfit to eat. This contains a large number of seeds, which when dry are collected by the Arabs, who extract from them an oil which is used medicinally and for dressing camels' wounds.

The chief trees are: the Sial,[*] a hardy, well-grown tree, which is to the desert what the Sunt[†] is to the valley of the Nile; it yields a hard, dark, and extremely durable wood, and its bark is used for tanning purposes; it also produces a gum which is used as a substitute for gum-arabic—the true gum-arabic being the product of the Sunt. The Futneh[‡] somewhat resembling the Sial in appearance, but distinguished by its blossom, which has a delicious perfume: this tree also exudes a considerable quantity of useful gum. Both these trees are now comparatively rare, especially the larger examples, as they have been cut down for their wood and for the manufacture of charcoal, a practice which unfortunately still prevails. Rarer still is the Egleeg,[§] a well-grown tree with irregular boughs and tufts of close bright green foliage with long, straight thorns; the wood, though light, is said to be strong and durable, and is much in favour with the Arabs for fashioning the *assoia*, a thick curved fighting staff.

The most common tree of the desert is the Sumra, or camel-thorn, which has a bushy growth, several strong branches springing directly from the ground and terminating in a flat top of thorns and scanty leaves somewhat resembling those of the Acacia. Its chief value is as food for camels, who seem to delight in its bitter foliage and long, forked, penetrating thorn. Perhaps the most important tree of all is the Dom or Theban palm[||] which, being carefully preserved by the Arabs, grows abundantly in many of the moister wady beds. It is a fan-leafed palm of moderate height (25 feet to 30 feet) often with a bifurcating stem which sometimes bifurcates again. It bears numerous clusters of hard nuts which are edible, and in size and appearance somewhat resemble large black plums; these are sometimes eaten by the poorer Arabs, although they certainly form a very indifferent article of food. Its timber is tough and fibrous and is largely used for beams and roofing, also for supporting the sides of wells, to which purpose by its damp resisting qualities it is well adapted. From the shredded leaves are woven mats, baskets, brushes, sandals, etc., and the leaf fibre being further pulped may be spun into a rough but very durable rope.

PRODUCTS.—Broadly speaking, if we omit the cattle raised upon its meagre pasturage, the land produces nothing. The little gum there is, is too broadly scattered to be worth collecting, and the products of the Dom here enumerated, although useful in themselves, cannot compete in point of cheapness with similar manufactures along the Nile. In the absence of water, agriculture is impossible, while the little charcoal produced and transported to the river impoverishes the country out of all proportion to the small measure of enrichment of its people. It is therefore to its mineral wealth alone that this portion of the Sudan must look for any possible prosperity, and it is little to be wondered at that the Government should offer every needful facility for its proper exploration and the development of its mineral resources.

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[*] *Acacia Arabica.*

[†] *Acacia Nilotica.*

[‡] *Acacia Farnesiana.*

[§] *Balanitis Egyptica.*

[||] *Hyphaena Thebaica.*

Drift Wood and

Dom Palms.

Government.—The Concession is within the jurisdiction of the Sudan Government, whose headquarters are at Khartoum. For administrative purposes the Sudan is divided into ten Districts, and the Concession is in the Halfa District, the administrative centre of which is Wady Halfa on the Nile. This is distant by rail 50 miles from the Concession and about 150 miles from the Om Nabardi Mines. There is at present no civil or military force within the limits of the Concession, and no local authority nearer than Wady Halfa. The presence of such for the safe conduct of the Syndicate's operations hitherto has fortunately not been required, although if any considerable work is undertaken here and a permanent mining camp established, recognised legal authority and punitive power will be necessary as a check on the spirit of lawlessness which would otherwise prevail.

PART II.

GEOLOGICAL.

(A) ROCKS.

STRUCTURAL.—The geological structure of the country may be briefly described as a foundation of grey granite merging into gneiss and supporting, with apparent unconformability, an extensive series of micaceous, talcose, and hornblendic schists and shales, clay slates and crystalline limestone. Above these, with probably a long break in geological age, a formation of conglomerates, sandstones, argillaceous limestones and various coloured shales; and above these again, in distinct unconformity, the marls and sandstones of Cretaceous age, now so well known under the name of Nubian sandstone. Among the older rocks described are broad areas of igneous rock which in many cases appears to be intrusive, while in others, and especially among the more basic varieties, the balance of evidence seems to point to a contemporaneous origin. Intrusive dykes are common in the granite and in the older schistose series; but in the second group of sedimentary rocks no certain and conclusive evidence of igneous intrusion could be found, and the upper or Cretaceous series appear to be entirely undisturbed. It would thus seem that igneous agencies played a great part in the formation and deposition of the older schists, while the period represented by the break between them and the succeeding group would appear to have been one of great volcanic activity.

No attempt has been made to correlate these rocks with similar formations of any particular geological system. No fossils of any kind have been found in the present survey, and in the absence of such it is impossible to speak with any degree of certainty as to their probable age. In lithological characters the schistose rocks resemble in many respects those of Cambrian age, although conceivably of an earlier date. Those of the second group have their nearest lithological counterpart, perhaps, in upper Silurian rocks; but if this represented their correct geological horizon it might be expected that some palæontological evidence would have been forthcoming from such a usually prolific source. It should, however, be stated that no very diligent or systematic search for fossils has been made in the present survey, which, being chiefly for gold, has been confined to the rocks less likely to contain evidence of fossil life. A few supposed fossils were collected, but these on examination with the microscope have proved to be chemical accretions due to other causes.

GRANITE.—This is the oldest and most extensive formation in the Concession. In some of the hills and under many hundred square miles of sandy plain it is of the common grey type, with the usual constituents, the mica being almost invariably biotite. Where it can be followed directly into the succeeding formation the latter is found to be a coarsely foliated gneiss, often hornblendic and containing spherical inclusions of darker crystalline hornblende schist. As a rule, however, the surface is denuded and the transition is to a rock of much more recent age. No considerable areas of typical gneiss were observed in the Concession and the rock seems to be confined to marginal transitions of the old grey granite. Over certain areas, and particularly in the larger hill masses, granitic rock of another character is seen, the mica being replaced by hornblende, and felspar predominating to the almost entire exclusion of quartz, so that it becomes difficult to decide whether to class it as granite or syenite. The felspar continues monoclinic, but the colour has usually changed to a bright pink. It is considered that this rock is of more recent age than the grey granite, and it has the appearance of being eruptive and intrusive, forming as it does isolated hills amongst stratified rock, and the centres from which many euritic dykes can be traced into the surrounding country.

SCHISTS.—Next in order to the gneiss is an arenaceous mica schist, between which and the granite, however, gneiss does not invariably intervene. It contains so much quartz that it was at first classed as a schistose sandstone, but there is now little doubt of its true character, or that it constitutes the lowest formation overlying the gneiss. In this rock massive bands of quartzite are common, which often stand up in rugged ridges forming considerable hills. Bands of arkose also occur, but are less conspicuous. Above these are a series of clay-slates alternating with more or less schistose rocks, sometimes talcose, but oftener chloritic and micaceous. These are succeeded by more calcareous rocks, the purer varieties of which have been metamorphosed into a coarsely crystalline saccharoid marble, while others have been compressed into a tough, amorphous rock which in appearance and fracture resemble the finer varieties of trap. Extended observation seems to justify the conclusion that the above is the natural order and sequence of the members of this older group, although it is but rarely they are found superimposed. At some points, notably at El Eshbab, the limestone occurs directly on the granite; while at Abu Hamed a white crystalline marble appears to be actually interbanded with gneiss, and has been followed to some depth for the purpose of lime-burning—an industry which has been in existence there for some years.

SEDIMENTARIES.—Of the second group the basal member appears to be a coarse conglomerate consisting of well worn fragments of the older rocks cemented in a dark, compact matrix which itself is semi-crystalline. Above this is a calcareous sandstone with numerous thin bands of more silicious character which have been changed into hard quartzite. Where the strata are much tilted the basset edges of this quartzite stand up some inches above the surface in knife-like ridges, thus enabling the intricate convolutions of the beds to be traced with great ease. There is evidence of great pressure and contortion, although no distinct intrusion of igneous rock has been observed. Succeeding these are a series of coloured shales, more or less calcareous, above which is an extensive formation of dark blue argillaceous limestone. The latter has a finely laminated structure, weathering into broad tabular masses which, with their characteristic blue-grey colour, give these limestone hills a very striking appearance. The series is much tilted and shows evidence of great regional compression, but there is no indication of that acute contortion observable in the silicious rocks below.

CRETACEOUS.—Little time has been given to the study of the series whose chief representative is the Nubian sandstone. It is usually assigned to the lower or middle Chalk formation, and is said to *underlie* the Cretaceous series of Upper Egypt. It covers a great part of the north-western quarter of this Concession, forming a high plateau from which rise occasional exposures of the older rocks. Isolated outliers are found all over the Concession, and there is little doubt that it formerly extended in an unbroken reach a great distance further south. An excellent section is afforded at Jebel Rafit where it rests directly on the granite and is laid down horizontally against the latter's varying slopes. In the deeper gullies of this hill range a dark boulder conglomerate is seen, composed of fragments of the older rocks imbedded in a stiff ferruginous clay. It is anterior to the sandstone and is probably a local formation dependent on the pre-existing hill. The true basal member of the sandstone series is a light-coloured quartz conglomerate, apparently of sub-aerial formation, in which the fragments are much less worn. The prevailing colours of the sandstones are yellow and light browns, but the formation is interspersed with thin bands of more compact nature in which the cementing material is silicious limonite. These withstand weathering better, and consequently the Nubian sandstone areas are usually covered with dark brown slabs which completely conceal the more friable rocks beneath. Nodular concretions of a similar character are also frequent, the nucleus being usually a fragment of the original sandstone around which have collected compact bands of rusty-brown quartzite.

IGNEOUS.—The igneous rocks of the Concession offer a complex problem, and especially is this the case in connection with the older schists. For convenient reference in the field, these rocks (except the granitic varieties already described) have been divided into two classes, based more on their lithological characteristics than on their supposed origin or mode of occurrence. The first includes the crystalline diorites, gabbros and diabase rocks usually associated with the older schists, while the second comprises the more glassy and lithoidal varieties,—the felsites, basalts, and porphyrites, which in many parts of the Concession extend in unbroken sequence over hundreds of square miles. The constitution of these rocks and the study of their relationship to each other and to the surrounding schists is a subject which, though full of interest to the geologist, does not properly come under the scope of this inquiry, except as regards their influence on or connection with the mineral deposits. That they have exercised such an influence is beyond a doubt; in fact so clearly evident is it that the occurrence of gold depends primarily on the presence of an igneous rock, intrusive or otherwise, that to look for it elsewhere may be regarded as a waste of time. This fact was evidently as apparent to the ancient workers, for although the Concession from end to end bears evidence of careful prospecting, some of which was no doubt unsuccessful, the scene of work, except in the case of alluvial deposits, was never far removed from the areas of igneous influence.

The rocks of the first group above referred to, in their more crystalline exposures display a massive granitic structure and weather a dark iron-brown, which gives place to a light bluish grey where cleaned by sand attrition. Finer grained varieties frequently assume a foliated structure, weathering buff yellow to brown, and have in the field all the appearance of true schists. In these the predominating mineral is chlorite, resulting probably from hydration of the ferromagnesian constituents. Actinolite is also a common constituent of these rocks. Frequently associated with them, and notably at Nabi, Nabardi, Om Gat and Khabaseit, are very considerable developments of a tough, grayish-green, micaceous and chloritic schist which displays a characteristic "spindley" or prismatic structure, pieces two feet long being as little as two by two inches in section. Such structure might be produced in a highly compressed phyllite, but from the invariable association of this particular rock with others of undoubted igneous origin, into which it seems to merge by insensible gradations, it is doubtful whether it should be classed as a schist, in the sense in which that word is usually applied to a metamorphosed rock of sedimentary origin. Indeed, the whole question of the structure of these older schists and their relationship to the more igneous types is one requiring much study and elucidation before an opinion can be expressed as to their probable origin. In and around Murat the indications point to a widespread plutonic upheaval among previously deposited sedimentaries, parts of which remain included; while at Sinayat the appearance is that of intercalated lava flows. At places, however, the rocks merge one into the other so gradually and with such apparent uniformity in mineral constituents that the observer is inclined to ascribe them, crystalline and foliated alike, to a common origin.

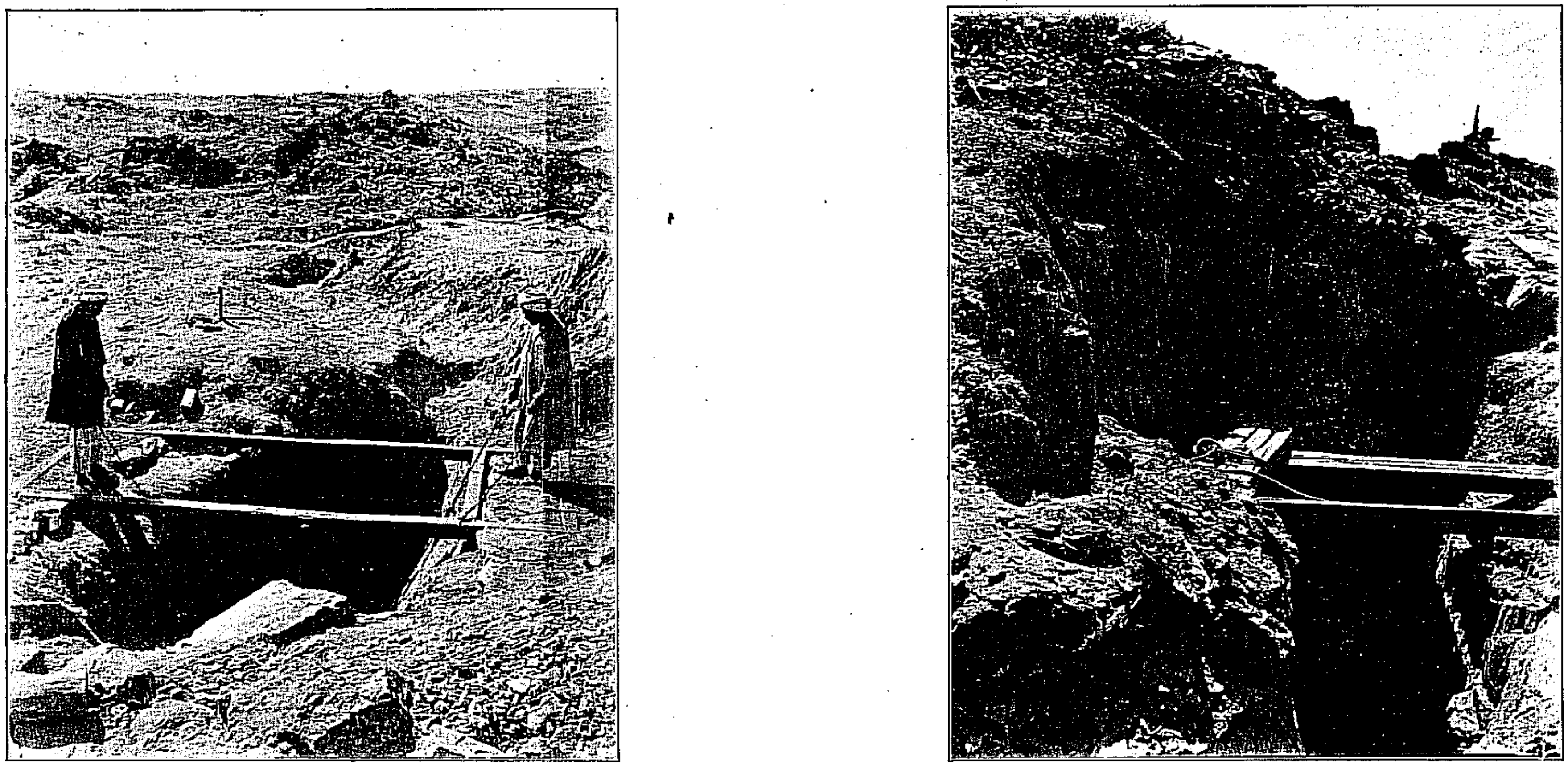
The volcanic rocks forming the second group are sometimes found associated with the more crystalline formations above described, and it is possible that in some instances they merely represent less crystalline portions of the same eruptive mass. In other cases, however, as in the hill ranges of Tana Shaib, Kermai, Butna, and Abu Barid, there can be little doubt that they are the result of a far-reaching extravasation of volcanic matter occurring long after the deposition of the older schists. They vary in texture from coarse porphyry to a dark-green aphanitic rock, which has been classed as andesite. In more glassy portions of this rock the ground mass is pale in colour, varying from yellow-brown to greenish-white. Olivine and pyroxene are common constituents, and free silica is often observable to the naked eye. It has usually a spheriodal structure and weathering has resulted in the formation of dark, rounded hills strewn from top to bottom with small, rounded, dark brown boulders. Where from any cause there has been recent movement of the loosened surface, the kaolinised selvage beneath displays itself in brightly coloured scars and patches, which render the hills easy of recognition at a great distance. In many of the hills a banded structure is observable, and often where a section is disclosed in the side of a ravine the rock has the general appearance of a bedded aqueous formation. In the far eastern part of the Concession, east of and around Labasoi, is a big spread of igneous rock of more acidic character than those above described. It is light buff in colour, weathering rusty brown, in irregular ragged hills. The rock has been provisionally classed as euritic felsite.

(B) MINERAL DEPOSITS.

Irregular Deposits.—Associated with many of the older limestones are irregular deposits of hematitic limonite which, if fuel were cheaply obtainable, might be of some commercial value. One of the biggest of these deposits is seen capping a white limestone range west of Jebel Lebasoi, and between that hill and Wady Terfowi. Bands of compact but rather siliceous limonite are also found in Jebel Rafit, at the base of the Nubian sandstone, and these at places appear to have been a little worked. Mention should also be made of an abundant occurrence of pseudomorphic limonite in a tough gritty limestone forming one of the lower beds of the sedimentary group of rocks above described. So largely is this mineral developed that the rock has at places the appearance of a brecciated conglomorate, and the surface of the ground is strewn with countless millions of black, shiny cubes varying in diameter up to one inch. Other ores of iron were found at various localities, though not in extensive formation; and for obvious reasons but little attention has been given to iron deposits in the present enquiry. It was expected that lead ores would be found in the Concession, the conditions being favourable for its occurrence, and a careful lookout has been kept for any indications of its presence, as an argentiferous galena might be worth attention. No lead deposit has, however, been discovered, and the little galena found has been confined to spots and veinlets in the quartz reefs. With the exception of auriferous quartz reefs and other veins carrying silver and gold, it may be said that no mineral deposit of value has been found.

Quartz Reefs.—These occur in nearly all the rocks described, with the exception of the newest series; but the only ones which have been found appreciably auriferous were contained either in the finer trap, or in the schistose rock so closely allied to diabase. Almost all the ancient mines found were on veins traversing one or other of these formations, or in the alluvium of valleys where detrital gold had collected from the disintegration of similar rocks. The largest reefs and the most important from a modern point of view are those which occur in the schistose rocks. In these the developments of quartz at places assume huge proportions, and whole hills rising to 100 feet or more are seen which consist almost entirely of that material. The usual breadth, however, is from one to six feet, and it will often vary as much as this in a distance of 100 feet, the quartz sometimes splitting and spreading out into a multitude of small veins. Though not, strictly speaking, continuous, a sequence of veins may often be seen extending over a length of several hundred yards, the composite sections having uninterrupted runs of some hundreds of feet. In almost every case they are in some degree auriferous, the richness seeming as a rule to vary inversely with the breadth. The quartz is white, bluish-white, semi-transparent to opaque, and usually displays a hackly fracture suggestive of granular structure. The outcrop is usually much stained with oxide of iron, and below surface the chief minerals included are hematite, mispickel and galena—usually in such small quantities as not to affect the value of the stone, which may be said to be free-milling.

The quartz veins occurring in the more lithoidal traps differ from the above in many ways, and are characterised by their persistent narrowness. They vary in breadth from a mere stringer up to six or eight inches, rarely reaching a foot; but as regards the length little can be said with certainty, the small outcrop being so easily concealed by float-stone. Ancient workings on these veins have been found extending for 500 to 600 feet, and a continuation of the vein is usually to be seen at the ends. The quartz varies in colour from opaque-white to semi-transparent pale blue, the margins being usually tinted a characteristic heather-red—probably by the silicate or carbonate of manganese. In very small veins the quartz is tinted throughout, but in the larger ones the red colouration is confined to the sides. Such veins are almost invariably auriferous, and the red colouration seems to have influenced the former workers in their selection of the points for operation. Copper occurs in many of these veins in sufficient quantities to have produced showy outcrops of the green and blue carbonates; but it is doubtful if any of them contain enough of the metal to pay for work, or even for separation as a by-product in the event of their being worked for gold. Some of the ancient works being situated on portions of the vein which are conspicuously rich in this cupric efflorescence, suggest at first the possibility of their being worked for copper; but an examination of the dumps shows the copper ore discarded, and the presence of gold in the soil, with the usual gold recovering appliances about, must be taken to indicate that these, like all the other Mines yet discovered, have been wrought for gold.



Clearing Old Works at Om Nabardi.

PART III.

MINES AND MINING.

(A) ANCIENT.

HISTORY.—There is abundant evidence that the mining industry of ancient Egypt covered a most extensive field, and dates from a remote antiquity. Mr. Ernest A. Floyer, in a contribution to the Journal of the Royal Asiatic Society before referred to, after a careful review of the evidence available, concludes that even before the times of the ancient Egyptians, or in the earliest times contemporary therewith, although unknown to them, the mountains between the Nile and the Red Sea were searched and worked for gold by a people whose chief occupation was mining. It is supposed that these former inhabitants of the Etbai were a Negroid race whose descendants at the present day dwell south of Kordofan, and work the copper mines of Hofrat and Nahas.

The Phœnicians visited this ancient people to trade for the gold of the mines before Egyptian oppression had driven them further south; and for the Egyptian kings there flowed from this source a stream of gold the volume of which, accumulated in the course of centuries, is now beyond conception, enabling them as it did to supply the civilized world.

The earliest known reference to gold appears to date from the era of Menes, the first historical ruler of Egypt, who is supposed to have reigned about the thirty-eighth century B.C. It is an enactment by which the exchange ratio between silver and gold was fixed at 2½ to 1,—thus indicating that even at that far distant date the precious metals were in common use as means of currency.

Floyer is of opinion that the first mines worked by the Egyptians themselves were in the Sinai Peninsula and were opened under the rule of Senoferu at the close of the third or beginning of the fourth dynasty, a period contemporaneous with the building of the first pyramids.

would appear that not until the beginning of the Ptolemaic period (4th to 1st century B.C.) was the industry again prosecuted with anything like its former vigour.

According to Mitchell[*] certain hieroglyphic inscriptions found in a temple at Hammamat, place the date of re-opening the mines under this period at about 240 B.C. in the reign of the III. Ptolemy, Eu~~re~~ergetes, under whom the foreign power of Egypt reached its proudest height. The annual output of the mines under the Ptolemies is said to have reached a value of five millions sterling; and Strabo tells us that down to the days of the XIII. Ptolemy (80 B.C.) the royal revenue was between three and four millions, a great part of which no doubt must have come from the mines.

Agatharchides, Diodorus and Strabo, who flourished during the 1st century B.C. described many of the mines very minutely and traced their history back to the times of the early Egyptian kings; but with the advent of the Roman period of occupation (B.C. 40) all further record ceases and the mines seem once more to have dropped into oblivion.

Towards the end of the 9th century of the Christian era, Roman rule having given place to Mahommedan ascendancy, the mines again received attention. Macrisi, the Arabic historian, tells us that in the reign of Ahmed-ibn-Talun, one Abderrahman el Omari, a descendant of the Khalifas, re-opened the mines at Um Gerain, about eighty miles from Esneh on the Nile. Following this he worked mines further south at Ceija; later still, at Jebel Essewed; and finally the more important gold mines of Dereheib. Accompanied by a hundred thousand men, this adventurer's career was one long record of pillage and oppression, which, after thirty years of bloodshed and treachery, ended in assassination by his own followers. History gives us no record of the result of this working of the mines; but the gold obtained must have been considerable even to admit of the maintenance of so great a number of men, the supplying of whom is said to have employed sixty thousand camels bringing provisions from the Nile.

This concludes the history of the mines, there being apparently no record of any work subsequent to the Arabian effort of the middle ages. It may, however, be mentioned that Sir J. Gardner Wilkinson in his learned work on the Ancient Egyptians makes reference to certain Cufic inscriptions found by Mr. Bonomi in the Eshuranib mines, which point to their having been worked in the years 951-989 A.D. This date, if correct, brings us down to a period nearly 100 years later than the Khalif el Omari. The same writer further states, though on what authority does not appear, that the mines continued to be worked till a much later period than the 10th century A.D., and that they were finally abandoned because the amount of gold obtained barely covered the expense of work.

In 1831-2 Mahomed Ali, then Pasha of Egypt, commissioned M. Bellefonds Bey, Director-General of Public Works, to survey and report on the mineral belt lying between the Nile and the Red Sea. This report describes many of the mines and the supposed method of work at great length, and attempts to distinguish between the work of the Egyptians and the later efforts of the Arabs. Even the mines of the

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[*] "Reconnaissance des Anciennes Mines de Hammamat" Caire 1879.

Ptolemaic period appear to this author to be distinguishable from those of more ancient date, although no monuments or inscriptions were discovered and no steps were taken to clear the *debris* from the pits. Ancient mining sites are recorded in the following localities :—

Om Garriat.
Ceija.
Uffain.
Ahudalala.
Machuchenaye.
Um Gabrille.
Tamille.
Esseved.
Telat Abda.
Om Taiour.
Wadi Sohone.
Wadi Hegatte.
Wadi Affave
Wadi Daguena.
Wadi Camolit.
Dereheib.
Kavanib.
Rafit.
Kelli.
Ahsiha.

Many of the localities enumerated above are included in this Syndicate's Concession, and have been re-visited in the present survey. A detailed description of these, together with other ancient mining sites discovered, will be found on page 36, *et seq.*

Method of Work.—Most of the mines are in a fair state of preservation, and the method of work is easily conjectured. Generally speaking, the conditions observed are in accordance with the description of Agatharchides, who wrote in 113 B.C. The following is a free translation from the text of Muller :—

> "The metal-bearing rocks which are called gold-bearing are intensely black, but among them is produced a stone than which nothing is whiter. Of these mountains, those which are rugged and have an altogether hard nature they burn with wood; and when they are softened by fire they experiment on them and cut the loosened stones into small pieces with an iron chisel."
>
> "But the principal work is that of the artificer who is skilled in stones. This man shows to the diggers the track of the metal, and apportions the whole work to the needs of the wretched men in the following manner: Those whole in strength and age break the places where shines the white stone with iron cutting hammers. They use not skill but brute force, and thus they drive in the rock many galleries, not straight but branching in all directions like the roots of a tree, wherever the stone pregnant with gold may diverge."
>
> "These men thus, with candles bound on their foreheads, cut the rock, the white stone showing the direction for their labours. Placing their bodies in every conceivable position, they throw the fragments to the ground, —not each one according to his strength, but under the eye of the overseer who never ceases from blows. Then boys, creeping into the galleries dug by the men, collect with great labour the stones which have been broken off and carry them out to the mouth of the mine."

" Next, from these a crowd of old and sickly men take the stone and lay it before the pounders. These are strong men of some thirty years of age, and they strenuously pound the rock with an iron pestle in mortars cut out of stone, and reduce it until the largest piece is no bigger than a pea. Then they measure out to others the pounded stone in the same quantity as they have received it."

" The next task is performed by women, who, alone or with their husbands or relations, are placed in enclosures. Several mills are placed together in a line, and standing three together at one handle, filthy and almost naked, the women lay to at the mills until the measure handed to them is completely reduced. And to every one of these who bear this lot death is preferable to life."

" Others, called Selangeus,* take from the women the powder thus produced. These are the artificers in whom lies the power of carrying to the end this work of royal utility. They pour the stone already milled on a table rather broad and polished with a smooth surface, which, however, does not lie flat, but has a slight inclination. On this table they rub with their hands the dust mixed with water, first lightly and then with greater pressure."

" By this means the earthy particles are dissolved and flow down the slope of the table, but that which is heavy and worth anything remains on the wood. And when the Selangeus has frequently rinsed the matter out with water, he handles the dust lightly with soft thick sponges, and pressing lightly from time to time he absorbs from the table and throws away that which is soft and light, entangled in the web of the sponge."

" There remains to the Selangeus separated on the table that which is heavy and shines, and which on account of its weight is not easily moveable. This he transmits to the cooks, who, immediately they receive it by weight, put it into a clay pot, and in proportion to its quantity they add a lump of lead, some grains of salt, a little alloy of silver and lead, and barley bran."

" The pot's mouth being carefully covered and luted round, they cook it five days and five nights consecutively. On the following day, when the burnt materials are cooled, they pour them into another vase. They find none of the things which were put in together, but only a mass of molten gold, little less by weight than the original matter."

It is doubtful whether the historian's description refers to the period of the Ptolemies or to an earlier epoch of the Pharaohs ; but the things of which he speaks are there in evidence to-day : the iron cutters and stone mortars of the men ; the mills at which the women toiled ; the tables of the skilled Selangeus ; the furnace of the " cook" ; the pots in which he fused his gold ; the slags therefrom, and even the very charcoal of his fire; all are there, all save the miserable wretches who wrought this Herculean task, and of them there is no tale except the multitude of lowly mounds which mark the last resting place of man and woman and child.

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* Worker at the tables or *Serangex.*

Of these people Diodorus writes :—

> " The kings of Egypt condemn vast multitudes to the mines who are " notorious criminals, prisoners of war and persons convicted by false accusa- " tion—the victims of resentment. And not only the individuals themselves, " but even whole families are doomed to this labour, with the view of punishing " the guilty and of profiting by their toil. The vast numbers employed are " bound in fetters and compelled to work day and night without intermission, " and without hope of escape; for they set over them barbarian soldiers " who speak a foreign language, so that there is no possibility of conciliating " them by persuasion or through familiar intercourse. No attention is paid to " their persons, they have not even a piece of rag to cover themselves; and " so wretched is their condition that all who witness it deplore the excessive " misery they endure. No rest, no intermission from toil is given either to the " sick or maimed; neither the weakness of age nor woman's infirmities " are regarded; all are driven to their work with the lash, till at last, overcome " with the intolerable weight of their afflictions, they die in the midst of their " toil. So these unhappy creatures always expect worse to come than they " endure at the present, and long for death as preferable to life."

CHARACTER OF MINES.—The ancient mines examined during the present survey may be divided into three classes:—first, Alluvial; second, Shallow Trenching; and third, Vein Mining underground. Although there is no direct evidence to this effect it is probable that this classification also represents their chronological order.

The mines worked for alluvial gold sometimes extend almost continuously over several square miles, and consist of a multitude of shallow pits sunk through a stony over-burden to the rock beneath, which probably supported a sub-stratum fairly rich in gold. The smallness of the drainage areas, and the frequent occurrence of exploited patches on high ground, with little soil, preclude the possibility of this gold having been brought from distant sources by aqueous agency, and to this extent the word alluvial as usually understood is scarcely applicable to these deposits; for except in the few instances where a wady bed has been the scene of work, it is evident that the gold sought for has been the result of the breaking down *in situ* of numerous quartz reefs which were more or less auriferous. The detritus itself is mostly quartz, and the detrital gold recovered by the ancients was probably in a state of fine division, and not in the nugget form so characteristic of the usual alluvial deposit.

In no case has any evidence been forthcoming of the employment by the ancients of any system of sluicing; and indeed it would be difficult to perceive how the necessary supply of water could have been obtained for such a wasteful process. It is possible that some method of dry-blowing might have been in use, but present indications point to a system of sifting, concentration on tables, and grinding of the

Remains of Old Washing Tables.

concentrates in circular mills, the remains of which usually abound. It may be noted, however, that as a rule in these "detrital" areas, remains of washing tables are comparatively rare. Pannings from the sub-stratum, where any can be found remaining, almost invariably yield a little gold; but nothing in the nature of a nugget has yet been found.

The second type of mine to be described is peculiar in that it almost invariably occurs in a distinctly igneous rock,—often a porphyritic felsite. Here the gold occurs in bluish-white quartz veins, the margins of which are usually tinted with a characteristic heather-red, due probably to the presence of manganese. That there is an intimate relationship between this colouration and the occurrence of gold in the stone is evidenced by the fact of its careful selection by the former workers.

The workings on these veins usually take the form of a shallow trench, the *débris* therefrom being thrown out in continuous heaps on either side. Sometimes these trenches extend from the base of a high hill to its summit, and in such cases the red scars against a black background of weathered trap make them conspicuous for many miles. The shallow nature of the works is probably due not so much to any impoverishment or discontinuance of the veins, as to their persistent narrowness which, rich as they undoubtedly are, would not admit of their being profitably followed in depth.

It is possible, too, that these trench works were wrought by a people who had no knowledge of the art of subterranean mining. It would be foreign to the object of this report to enter the realms of speculation on so academical a point, but there is no doubt that an opportunity here presents itself for some more learned pen to attempt the correlation of the period with the type of work. To accept the crude efforts above described as contemporaneous with or subsequent to the galleries of Dereheib, or the shafts at Om Nabardi, is to ignore the principle that all art is progressive—even the art of mining. M. Bellefonds Bey considers that the Arabs of the middle ages were fearful of working underground, and that their work at Dereheib was confined to the shallow parts of the mine and to the "entrance to the reef." The natural assumption, however, would be that the shallower parts were the first excavated, and that the interior galleries represent the efforts of the later workers.

The writings of Diodorus leave no doubt that the art of underground mining was known in Ptolemaic times; but there appears to be no reason to suppose that this method was in use in the days of the earlier Egyptian kings. Still less reason is there to believe that the method was *unknown* to the Arabs, or that knowing it, they preferred the crude example of an earlier age. The important mines of Ceija were almost certainly of Arabic creation, and further south in this Concession are similar mines where an obituary inscription in Cufic characters has been found which places their Arabic origin beyond all doubt. The prevailing types of ancient pottery discovered in the mines are Arabic; the names of most of the localities where mines are found are Arabic; and the conclusion is forced upon us that, in this Concession at least, it is to the period of Arabian occupation we must refer most of the important mines which in classification come under the next head.

The third type of mine is the subterranean, in which the workers must have left the light of day and pursued their avocation by the aid of artificial light. The prevailing method of work was to sink a number of shafts along the outcrop of the vein and to connect the same by tunnels underground, subsequently removing the contents of the vein until, with the exception of a few pillars left at necessary points, the whole was extracted. It will be seen that in effect this embodies the whole principle of vein mining to-day. That these underground stopes were not merely the fortuitous sequel of the second type of mine described is evidenced by the fact that in many cases the upper portion of the vein remains *in situ*, forming pillars to support the openings of the numerous shafts.

The workings rarely reach a depth of 100 feet, the deepest yet excavated at the Om Nabardi mines (see Plate XVIII) having been followed to about that depth, when it had to be abandoned on account of foul air.* In this working the vein seems to have been comparatively poor, for little stoping has been attempted, whereas in other parts of the mine the stopes are almost continuous. The workers seem to have preferred veins varying in thickness from a foot to three feet, a vein much thicker than this being rarely taken away in entirety, but followed along one or both sides.

APPLIANCES.—This custom was probably for the sake of safety, and in order to facilitate movement within the mine, for numerous footholds in the walls point to this as being the only means of egress; and in the absence of all large timber, ladders were probably unknown. Here and there, where the sides were weak, "hitches" have been cut for timber props, and some of these remain to-day in an excellent state of preservation. The timber is a species of acacia which is very common in the wadies, although of stunted growth. Tool marks are found in great numbers in the sides of the workings and appear to have been produced by a pointed iron tool impelled by some form of hammer. Only in one instance, at the Nabi mines, has any indication been found of the means of illumination; this consists of a portion of a broken lamp which, except for the fact that it had no handle, resembles the Roman lamp of to-day (see Fig. 3, plate IX). A similar lamp is said to have been found at Om Nabardi (Fig. 2) but this is somewhat doubtful, as the Arab who produced it had recently returned from the River, where such things are easily obtained. Had these lamps been in general use in the mines, it is reasonable to suppose that a fairly large number of them would have been found; in any case the smoke therefrom should be visible on the walls of the mine, especially round such niches as might be utilised for their support. But no such blackened spots are found and the marks of smoke are absent altogether. The marked absence of smoke stains on the walls raises another point:—if, as related by Agatharchides and Diodorus, fire had been employed in the working faces as a means of breaking down the quartz, some indication of this should remain at the present day. In other mines with which the writer is acquainted, where the ancient workers had employed this means of shattering the stone, the working faces were smeared with soot and smoke, and powdered charcoal was observable everywhere. There is also a characteristic conchoidal appearance in a

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* Ancient workings have since been found at the 160-feet level at Nabardi.

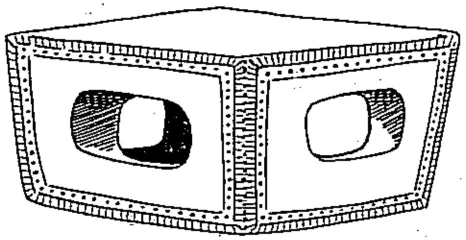

Fig 1.

Scale, one-half.

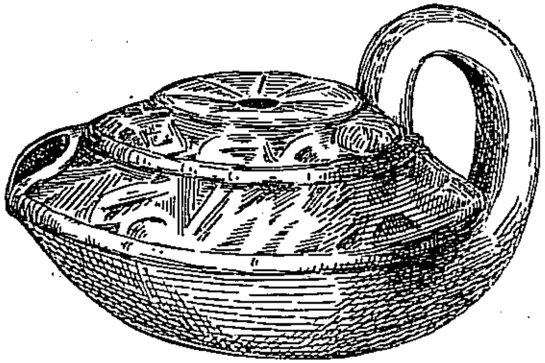

Fig. 2.

Lamp said to have been found at Nabardi.

Full size.

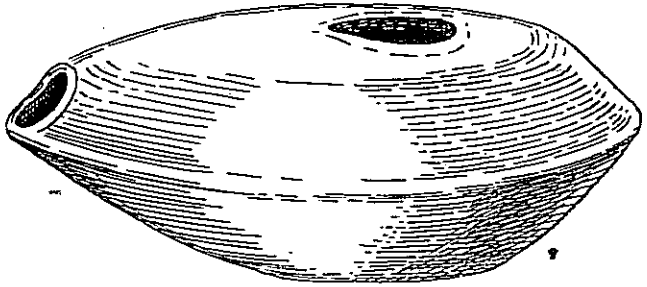

Fig. 3.

Ancient Lamp found at Nabi Mines.

Scale, one-half.

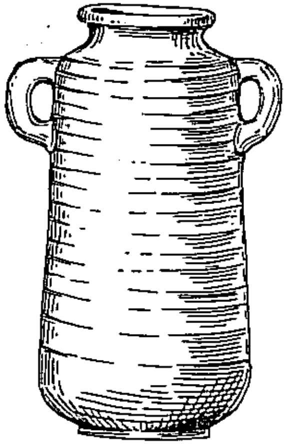

Fig 4.

Pot found at Nabardi, Partly Restored.

Scale, one-quarter.

Plate IX.

"burnt" end which is never observable in any of the working faces here. Taking these things into consideration, and also the great scarcity of wood which must have prevailed then as now, it is extremely doubtful if this firing process was ever employed by the people who wrought the mines in this Concession.

Whatever the means of obtaining the quartz may have been, the subsequent treatment thereof cannot have differed greatly from the accounts given by Agatharchides. There seems, however, to have been some process of hand selection which escaped that writer's observation, for from the abundance of partially reduced quartz found in the neighbourhood of the works, it is evident that not one-half of that taken from the mine underwent the final crushing. The selective process was probably based on the occurrence of visible gold in the stone, or perhaps on some attendant phenomena of which we do not possess the secret. In any case it was efficient in result, for the rejected stone is rarely worth more than a dwt. or two per ton, and has never been found to contain visible gold.

The selected quartz was further broken down and crushed on flat stones by hand mullers, with reciprocatory action, to a fine powder which was afterwards concentrated on inclined tables or strake-beds by the action of water. The concentrates from these tables appear to have been further ground in circular mills which were usually surrounded by small enclosures—probably to protect the powdered quartz from the wind, and to act as a support for some kind of protection to the worker against the direct rays of the sun. The tailings in and around these enclosures are very fine and slightly cemented, probably by the oxidation of pyrites, and there is usually a reddish brown tint which is not observable in the heaps adjacent to the tables and which supports the idea of concentration. The subsequent recovery of the gold from these concentrates might have been effected on the washing table or by the aid of broad flat dishes, the broken remains of which are common.

This differs in some respects from the descriptions of the ancient writers, but the essential features are the same, and in some of the localities observed the evidences of a preliminary concentration are wholly absent, the material apparently having gone direct from the sorters to the circular mills and thence to its final treatment on the tables. The presence of broken melting pots and quantities of scoriaceous slag confirms the description of the means employed for the ultimate separation of the gold from the baser metals, and that this process was a most effectual one may be inferred from the fact that no trace of gold can now be obtained by panning the slags. Mercury does not seem to have been known to the workers, or, if known, was evidently not employed as a metallurgical re-agent.

The preliminary breaking down of the quartz as it left the mine was effected by stone hammers, roughly cuboidal in shape, which have become worn on every side with a slight indentation in the centre of each face. The anvil was a hard stone slab, or as often as not the less weathered outcrop of the country rock, which is seen to be worn into a multitude of holes. The rubbing mills mentioned (as distinguished from the grinding mills) are flat pieces of the hardest rock procurable, usually dolerite or basalt, and the mullers—from 5 to 15 lbs. weight—are generally of the same material. The latter, being worn on both sides, are usually lenticular, the hollow in the lower stone being elliptical in shape, about 20 inches by 15 inches, and often as much as 4 inches deep. Frequently the stone has been turned and a similar hollow worn on the other side until both have met.

The circular grinding mills are from 18 to 22 inches in diameter, the nether stone being also of exceedingly hard rock. The mullers, which are pivoted in the centre, are usually of a softer material, a coarse-grained granite being the favourite, and the original weight would be about 50 or 60 lbs. The quartz was fed through a hole in the upper stone, and rotation was effected by means of a short stick inserted in a shallow notch. Some of these mills are worn to a depth of eight or ten inches, and, like the elliptical ones, many of them have been turned and used on the reverse side. It is a curious fact that very few of these nether stones remain intact. When not worn through they have in nearly every case been broken at the side, and this must of necessity have been intentional. The assumption is that when the former workers left the mines, these things being too heavy to remove, were purposely destroyed to prevent their use by others. The upper stones in many cases they appear to have carried with them, for these, besides being lighter, entailed more work in preparation.

The washing tables above referred to measure about 9 feet by 2 feet 6 inches, and are built of undressed stone with rubble filling. The upper surface was plastered smooth, and sloped at an angle of 1½ inches to the foot. As the table was usually built on ground which sloped in an opposite direction, the head of the table would stand about 2 feet 6 inches above the ground. A circular stone-lined cistern, 4 or 5 feet diameter, at the bottom of the table, served to catch the water which flowed therefrom, and this returned by a narrow stone-lined channel to a similar cistern immediately below the head of the table, whence it was raised by the operator with the aid of a small picotta or *chadouf*,* to be used on the table again. The sand or tailings collected in the first cistern, and was thrown out to form large heaps many of which remain to the present day. A small rectangular stone-lined pit is usually found alongside each table, and it is surmised that this was for the reception of the pulverised quartz as it came from the mills. No vestige of the *chadoufs* now remains, but fragments of thin iron vessels are sometimes found which would accord with the form of iron vessel used for similar purposes along the Nile to-day.

Hut Remains.—Not the least interesting feature of these ancient mining camps are the hut remains, of which great numbers are found at every important mining centre. The walls usually consist of a single thickness of undressed stones, supported by smaller fragments wedged into the crevices; but here and there a building may be seen where the wall is formed by two facings and a rubble filling; plaster of any sort being quite unknown. Occasionally a camp is found where the latter type of wall prevails. The height of the walls varies from 2 to 5 feet and the average may be taken as 3 feet above the ground. The plan as a rule is roughly circular, 8 to 10 feet diameter within, with no opening but the entrance, which is sometimes surmounted by a lintel, although this is very rare. No roof structure has

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* Arabic. The Bisharin equivalent is *nabardi*, whence the present name of the Om Nabardi Mine.

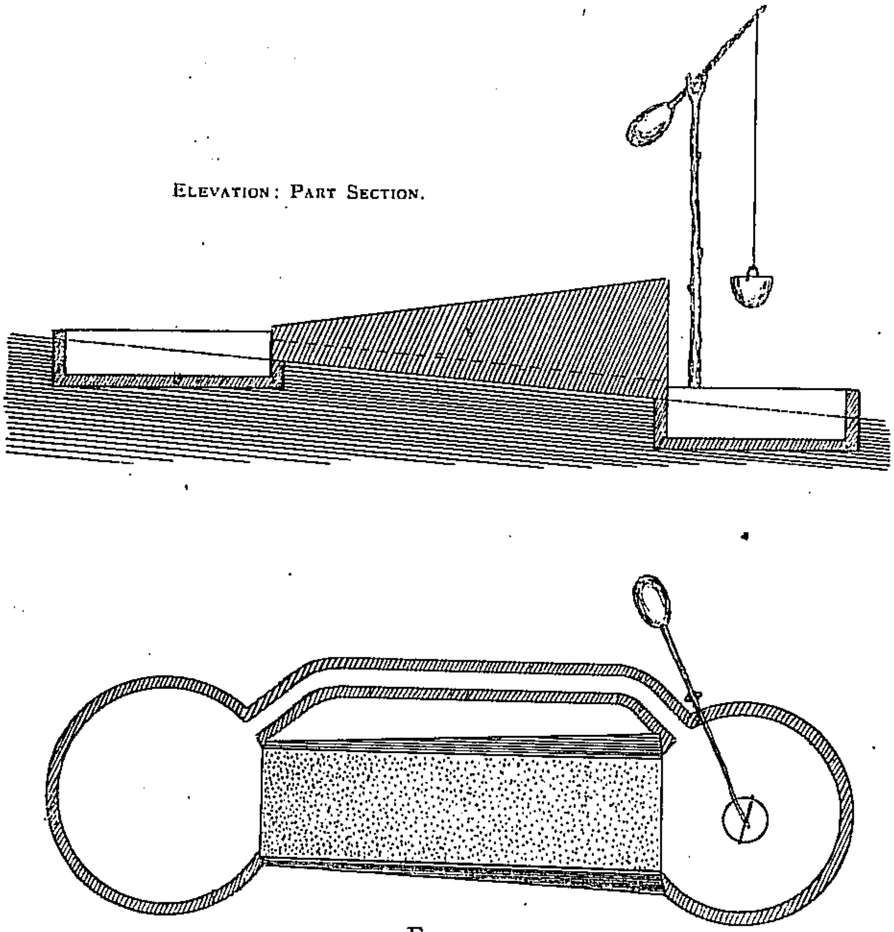

FIG. 5.

PLAN.

DIAGRAM ILLUSTRATING CONSTRUCTION OF WASHING TABLE.
Scale—¼ in. = 1 foot

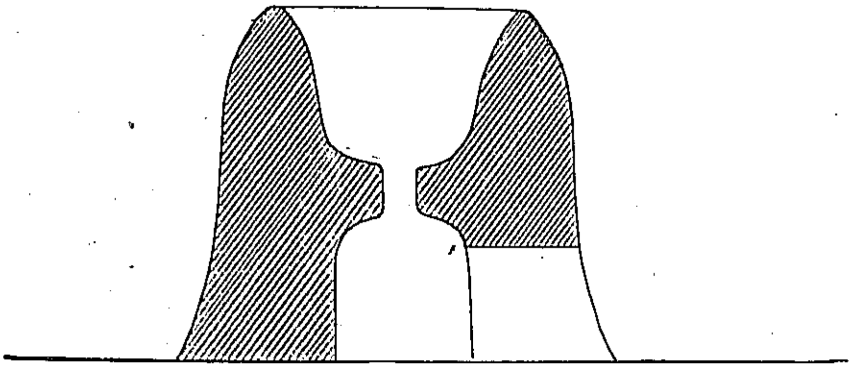

FIG. 6.

SECTIONAL ELEVATION OF ANCIENT FURNACE.
Scale—⅛th.

been seen, and the former covering was probably some kind of mat or woven material. The majority of the huts are single and detached, but sometimes they are found curiously grouped as shown in Fig. 21, plate XIV. A common form is that shown in Fig. 23.

At most of the mining centres the huts are scattered indiscriminately along the edges of the wadies, or at points convenient to the works; but towards the eastern parts of the Concession the tendency was to group them more closely, and at Khabaseit and Terfowi they are found arranged in compact blocks. This may possibly have been with a view to mutual protection and defence; but the general character of the walls and rectangular plan of the huts point to a different period of construction and the employment of a different class of labour. If, as Diodorus informs us, the Ptolemaic mines were worked by slaves, some form of supervision would be necessary in the camp no less than in the mine, and it would be obviously impossible to exercise this in a camp so widely scattered as that at Om Nabardi. The suggested inference is that these rectangular walls and close encampments may mark the scene of Ptolemaic work, whilst the scattered huts and isolated mills date from the period of Arabian occupation.

Against this hypothesis, however, it should be recorded that at Khabaseit are to be found the remains of one or two structures which appear to have been *musjids*—a simple form of mosque. These are about 12 feet square in plan, with a recess in the middle of the eastern end (Fig. 26). The recess is about 3 feet by 3 feet, and is supposed to represent the *mihrab* or praying niche, pointing in the direction of Mecca. This, if correct, would of course point to Mahommedan construction; and as similar remains are to be found in the Wady Mosci, where the huts are circular and scattered in the usual way, the evidence as regards the period of work is apparently negatived.

A great deal has been written about ancient dams and royal roads in the country between the Red Sea and the Nile. None such have been found in this Concession, and the only means of access to or communication with the mines are narrow foot-paths which serve as camel tracks and which might have been formed merely by kicking aside the loosened stones. Narrow walls of loose dry stone had been thrown across a few of the small gullies, and these might conceivably have retained a little water if carefully plastered; but beyond this nothing in the nature of an artificial reservoir has been discovered.

Ancient wells probably exist at many of the mining sites, for it is difficult to believe that the workers brought their water from such great distances as most of the present wells are removed from the mines. These wells would naturally be situated in low lying ground, thus facilitating their obliteration by blown sand and by occasional rain storms. A few attempts have been made to discover them at likely looking spots, but without success; and no systematic search, such as trenching a wady bed has yet been undertaken. Ancient wells have been discovered in the khors debouching from the Rafit Hills, and these, though quite refilled, were indicated by broad circles of stones.

Another curious construction which, however, seems to have no connection with the mining industry was often observed in the eastern part of the Concession. It consists of a circle of large stones forming a wall about $2\frac{1}{2}$ feet high, the interior of which is filled up flush with rubble and levelled off with a layer of small flat stones. The diameter is usually about 15 feet, though sometimes as much as 25 feet. Usually, but not invariably, they are in the vicinity of a well, and sometimes, as as Derebeheb, as many as eight could be counted in one group. It was at first supposed that these represented a form of altar, but on opening through one of them it was found to contain several human skeletons huddled together in various attitudes,—the victims, probably, of some ancient tribal fight. The bones were completely desiccated, and fell to powder under the touch.

The ancient burying places pertaining to the mines are usually situated in a wady-bed, in close proximity to the scene of work. The graves are irregularly scattered, but have almost invariably a general orientation north and south. They are from four to five feet deep and the body lies, with the feet towards the north, between two narrow ledges which support a bridge of stone protecting it from the superincumbent earth. At the top there is usually a ring of stones encircling the grave, with an upright stone at the head and at the foot. The space within the ring is often covered with small stones which are sometimes selected white quartz or rounded pebbles from the wady-bed. No erection has been found over any of the tombs, beyond a heap of stones, and in those which have been opened no find of archæological interest has been made. Where human remains have been found the skull is invariably of a Semitic type, and not Negroid as might have been expected.

Antiquities.—A great number of potsherds of various shapes have been found in the neighbourhood of the mines, and an attempt has been made to reconstruct some of these sufficiently to admit of a reproduction of their forms. The results obtained are given in Plates IX., XI., XII., and XIII. Those on Plate XI., however, are from intact specimens found buried in the sand. Fig. 9 illustrates the prevailing type, and fragments which could be identified with this design have been found in almost every ancient mining camp discovered. Fig. 1 is unique in its kind, and the manner of its use is uncertain. It appears to have been employed in connection with a fire, for the surface shows evidence of fire action, and it is possible it formed the support of an earthenware brazier. All the vessels are of common unglazed earthenware and usually of a brick-red colour. In only one instance was a fragment of glazed pottery found, and this is too small to indicate the form of the vessel; it appears to be from the edge of a very shallow basin.

Other articles found in the vicinity of the mines are: a short pointed iron tool, pierced for a haft, and corresponding to the modern single-pointed pick; a broad hoe, or "mamootie," with the eye attached by rivets; iron wedges, probably used for detaching rocks; packing needles, and various other small pointed iron tools; a pair of scissors; brass scale pans, pierced with holes for cord supports; some small copper ingots which may have been weights; portions of large bronze vessels, probably cooking pots, but extremely thin and bearing evidence of skilful manufacture; fragments of coarsely woven linen cloth; a stump of a small

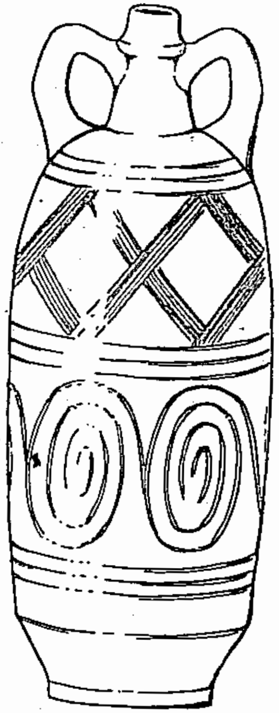

Fig. 7.

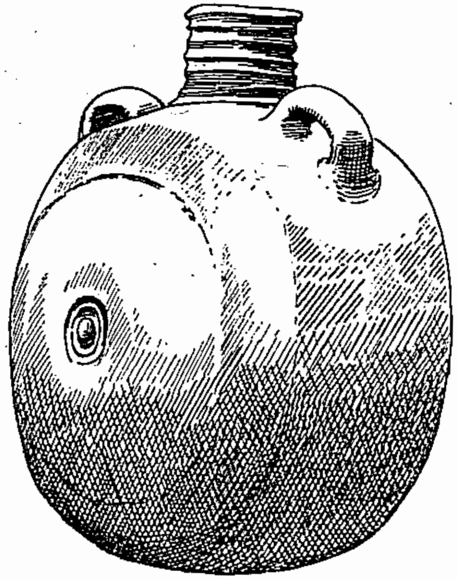

Fig. 8.

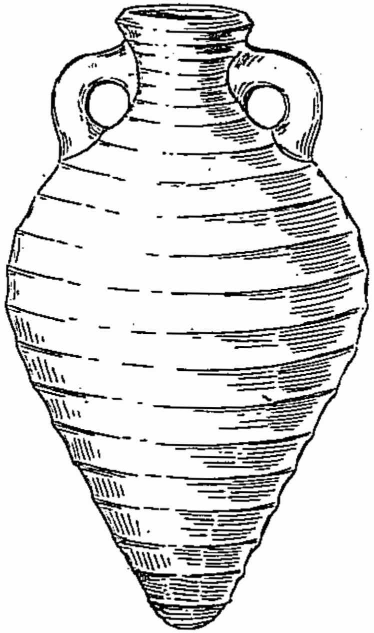

Fig. 9.

Ancient Pottery found Unbroken.

Scale, one-quarter.

broom made from the split leaves of the dom-palm; fragments of sea shells and ostrich eggs, probably used for the reception of gold dust; some beads and small articles of personal adornment; a small stone tablet inscribed with the emblem of the sun god Horus; numerous fragments of broken glass. The latter is sometimes of a pale straw colour, but most commonly a bright greenish blue. Unfortunately the fragments are too small to admit of reconstruction or a reproduction of the forms with any degree of confidence. The prevailing type seems to have been as represented in Fig. 16.

Mining Sites.—The ancient mining sites discovered in the Concession to date are as follows:—

Name.	Class.	Lat.			Long. E. of Greenwich.		
		°	′	″	°	′	″
Abu Dalala	Second	21	47	30	34	28	15
Abu Siha	?	20	35	25	33	2	45
Abu Tundul	First	21	38	50	33	40	20
Adarawib	First	20	25	10	33	6	0
Bir Towil	First and second	21	51	0	33	47	0
Butna	Second	21	45	0	34	30 & over	
Dabhalkaa	Second	21	1	0	33	59	0
Dayob	First and second	21	9	25	33	0	0
Esmat Omar	First	21	49	20	33	43	0
Fit-Fit	First	20	46	0	32	27	10
Hadal Moiet	First and second	20	30	45	34	1	10
Idarib	First and second	21	6	30	33	25	20
Khabeseit	First, second and third	21	7	45	33	55	45
Lesewit	Second	21	25	10	33	40	0
Mosei	First and second	21	10	30	33	7	0
Mundera	First and second	20	55	40	32	46	10
Nabi	First, second and third	21	13	20	33	41	40
Nabi Tana	Second and third	21	9	45	33	35	30
Nasb-el-Hosan	First	20	35	40	33	17	25
Omar Khabash	First	20	13	0	33	18	20
Om Nabardi	First, second and third	21	7	30	32	46	0
Rod-el-Ushal	First	20	40	10	32	37	40
Shashu-at-eb	First and second	21	40	30	34	10	40
Tana Sbaib	Second	21	12	15	33	35	30
Terfowi	Second	21	1	20	34	2	25
Tilat Abda	First and second	21	20	0	33	37	0
Ufain	First and second	21	47	30	34	23	30
Wady Dom	First and second	21	15	0	33	40	0
Wady Howe	First and second	21	46	45	33	42	20
Wady Romeit	First	21	15	40	33	37	10

Note.—Positions are approximate in seconds. Where possible they are corrected by Col. Talbot's triangulation. Latitudes are by solar observation and longitudes by dead reckoning.

Most of these are much alike in general characteristics, but a brief description of each is here given, chiefly for the purposes of record.

ABU DALALA.

At the north-eastern corner of the Concession is a bold mountain range striking WNW. and including the Jebels Machuchenaye, Butna, Abu Dalala, and Uffain. The first two hills are outside the Concession, the eastern boundary of which passes between Butna and Abu Dalala. The main range consists of a huge upheaval of volcanic rock varying in texture from coarsely crystalline diorite to glassy basalt. No granitic rock was observed within the area of the hills, and the trap was succeeded northward by the schistose series, north of which was granite. The lower hills flanking the main range on the SW. are of the igneous type (second group) described in a previous chapter. Among these hills numerous small workings occur, mostly in the form of shallow trenches along the outcrop. A great number of these, extending from Abu Dalala to Uffain, were visited and examined, but a description of each in detail would be tedious and serve no useful purpose. The most extensive vein seen occurred on the eastern side of Wady Abu Dalala at a point about two miles from the main range. Here a shallow trench-work, 140 feet long, had been opened along the outcrop, striking WNW. At the western end of the working is a small detached outcrop, 1 foot wide, of white barren-looking quartz; at the eastern end there is a blow of quartz 10 feet to 12 feet wide which has not been worked. Samples broken from the outcrop panned 2 dwts. of gold per ton. One hundred yards east of the trench, along the line of outcrop, is a small depression which has evidently been a prospecting pit, and the vein can be traced for thirty yards east of this. Two hundred yards further east, at a bearing ESE., is another trench work, 60 feet long, which is probably on the same vein. Like the first it is very shallow, and most of the quartz produced therefrom lies at the sides of the excavation. A sample from this panned 1 dwt. of gold to the ton. The total distance which this reef can be traced is thus about 400 yards; its size is from 1 to 2 feet, and the panning results of unselected stone 1 to 2 dwts. No huts were found in its neighbourhood, or mills or appliances of any description.

The most extensive workings seen in this area are on the other side of the wady, the largest found being about two miles NNW. of that described. It consists of a trench 200 feet long, striking north up the slope of a small hill and reaching to its summit. Most of the work appears to have been shallow, but towards the top of the hill it was deeper, probably 30 feet or more, judging from the size of the dump. Nothing can be seen of the outcrop and there is no means of ascertaining the size of the vein. From appearances it seems to have been only a few inches wide and to have consisted principally of white quartz, a good deal of which is scattered round the sides of the trench. Samples of this panned 1 to 2 dwts. of gold per ton. The locality is evidently auriferous, for a number of shoding holes can be seen in the sides of the small hills surrounding, and along the gullies the whole channel has in some cases been turned over in the search for detrital gold. About two dozen huts were found in an adjacent hollow, and one or two grinding mills. Twelve samples in all were taken from this group of veins, and the best result obtained in the pan was 3 dwts. of gold per ton. In this area, and in this only, indications were observed that the workings had been visited and sampled by a recent explorer.

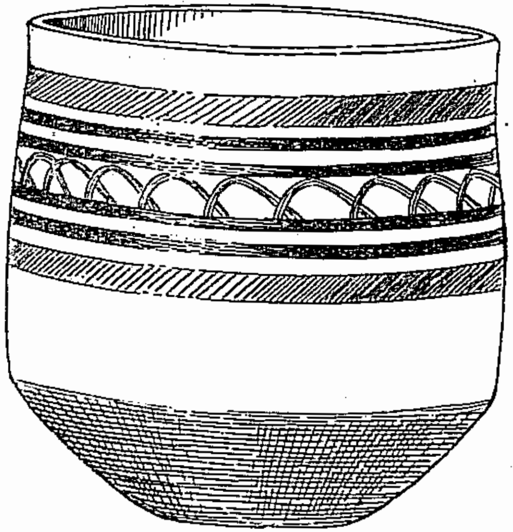

Fig. 10.

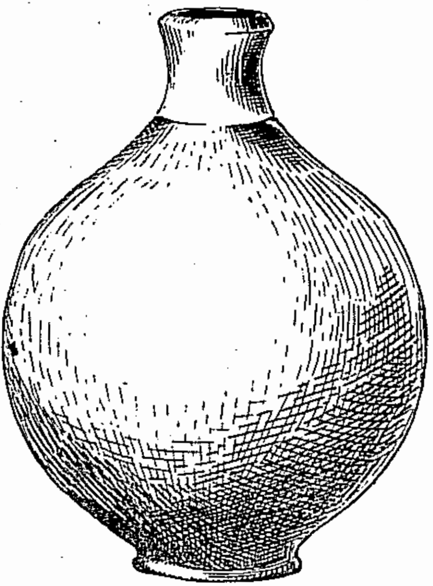

Fig. 11.

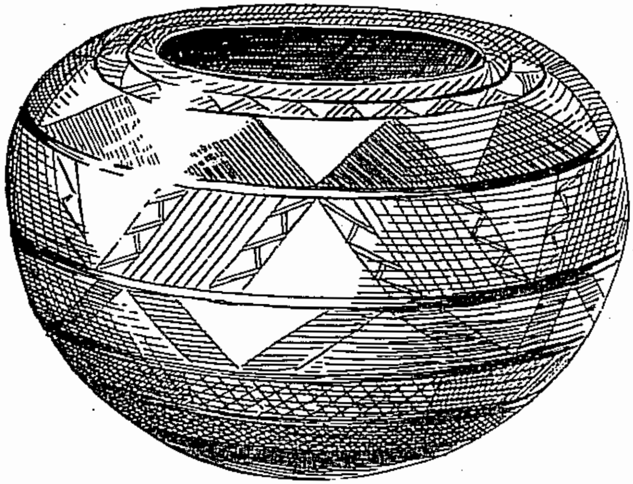

Fig. 12.

Ancient Pottery, Partly Restored.

Scale, one-half.

Plate XII.

ABU SIHA.

The caravan route from Murat to Abu Hamed, at thirty-five miles from the former station, passes through a gap in the Abu Siha range, on emerging from which a well-beaten track is seen leading to the left (east) towards a rocky khor in which is situated a deep water-hole. At the entrance to the khor the remains of numerous rude huts are seen, and from the presence of great numbers of elliptical rubbing mills among these huts it is inferred that they are the remains of an ancient mining camp. A few circular mills were also seen, broken pottery, fragments of glass and ostrich egg shells. The remains of a small furnace were also found, section of which is shown in Fig. 6, Plate X., and near this ashes, charcoal, fragments of bone, and a ferruginous slag resembling that found in other mining localities. Small heaps of broken white quartz were found, and it was evident that similar stuff had been treated in the mills; but two days of careful search among the mountains failed to discover the source from which it was obtained, and no trace of any mining operations could be found. It is therefore inferred that this quartz was brought from some distant source for treatment here on account of the presence of water in the hills. The geological formation of the hills is syenitic granite, with pink felspar. Fringing this are low, rounded, trappean-looking hills, which on closer examination prove to be of micaceous schist, but penetrated in all directions by basaltic dykes, the superior resistance of which to weathering influences has resulted in the whole surface being covered by broken trap.

ABU TUNDUL.

The Wady Abu Tundul flows westward towards the Gabgabba, taking its course between the Jebels Abu Tundul on the south and Areal Izrak on the north. The caravan route from Bir Abaraga to Bir Towil, after crossing this wady, goes northward into the Izrak range, and two-and-a-half miles from the wady crosses the watershed—to descend by a branch wady into the northern plain. Half a mile beyond the pass there is a beacon on the right of the course, and one mile beyond this the wady is joined by another coming in from the SE. About two miles up this latter wady and near its source are a number of ancient hut remains, and skirting the course of the wady for a length of 600 yards are a series of shallow pits evidently sunk to its former bed, the course having slightly changed. These were in all probability made in search of gold, as samples panned from the hills invariably showed traces of that metal; but no quartz veins were to be seen in the vicinity, and no grinding mills such as were commonly used for the reduction of quartz. The surrounding country is all volcanic (second group), a greenish-grey, semi-vitreous matrix with porphyritic felspar, hornblende, and pyrites. The area drained by the wady is very circumscribed, and it is supposed that the gold accumulated from the disintegration of very small quartz veins which would not be apparent in the talus, or from decomposition of the pyrites occurring in the rock.

BIR TOWIL.

The well which gives this locality its name is in lat. 21° 52′ N. and long. 33° 47′ E., approximately. It is situated in a narrow wady running southward between black rounded hills rising to 200-250 feet. On both sides of the wady, from the well downwards, for a distance of about a mile, are the remains of numerous ancient huts, clustered at the openings of the minor water-courses coming in from amongst the hills. These are accompanied by the usual grinding mills and quantities of potsherds. The remains of several washing tables were also found in this locality. A good deal of work of the usual alluvial character had been done in the wady bed, which at one place seemed to have been diverted for this purpose; but the chief workings to claim attention were shallow excavations dotting the hill sides, where the gold bearing matrix had been attacked *in situ.* This was a bluish-white ironstained quartz which occurred in short, narrow veins striking in every direction in a porphyritic felsite. They could rarely be traced more than a few yards in length and appeared to occur along the lines of contact of a finer grained igneous rock intruded in the porphyritic mass. Scrapings from the dumps around these pits invariably yielded a colour of gold in the pan. A sample of quartz taken from a small vein in one of the pits panned ten dwts. of gold per ton, and a sample of selected stone collected from among the huts gave a pan result equal to three ounces per ton.

BUTNA.

Refer to Abu Dalala, under which head these workings may be said to be included.

DABHALKAA.

The Wady Kua, flowing from the east, joins the Wady Nabi a little north of the Idarib mountain. Above this point the Kua is fed by the wadies Dumra, Khabaseit, Adoi and Dabhalkaa, the latter having its rise in the southern and western slopes of the high mass of Jebel Terfowi. About two miles SW. of the hill the two principal branches of the Dabhalkaa unite, and in the contained angle are a few shallow excavations which, from the presence of that metal in the *debris*, are evidently ancient workings for gold. They occur in a dark, fine textured volcanic rock (probably andesite) which here and there is porphyritic; it forms a fringe of lower hills skirting the main mass of Terfowi, which is granite, conspicuously red in colour from the presence of pink felspar. The workings are on small quartz veins similar to those described at Bir Towil, and in one case—the only one observed in the Concession—the working was situated in the granitic rock, but near its juncture with the trap. It is worthy of note in connection with this locality that a strong ridge of fine grained granite was seen actually *within* the trappean area, and appeared to be in the form of a dyke from the granitic mass, penetrating the trap. The granite was also found to contain many fragments and bombs of trappean rock. In addition to the trenches mentioned a good deal of shoding had been done in the small gullies running up the hill sides, but this is of little value as an indication of reefs, and no vein work of any importance was seen.

ANCIENT POTTERY, &c., FOUND AT THE MINES.

PARTLY RESTORED.

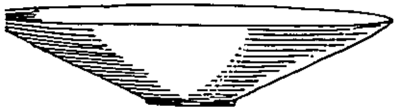

FIG. 13.

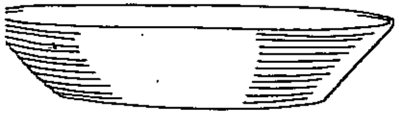

FIG. 14.

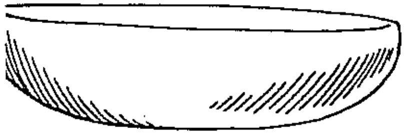

FIG. 15.

EARTHENWARE PANS.

Scale, one-quarter.

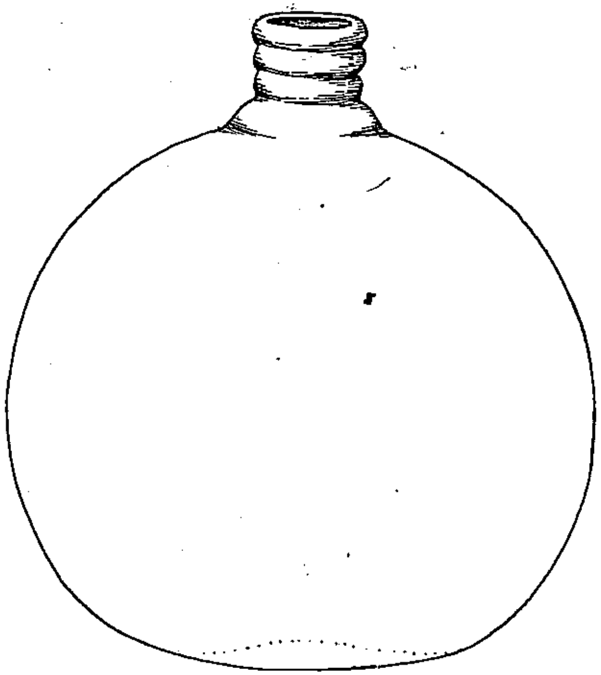

FIG. 16.

GLASS BOTTLE.

Scale, two-thirds.

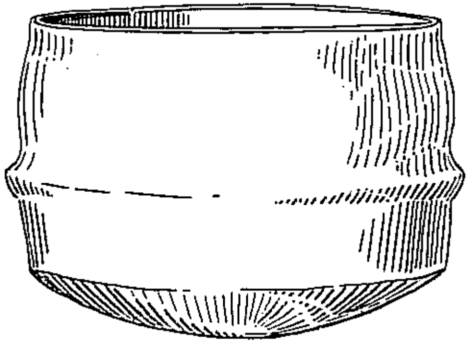

FIG. 17.

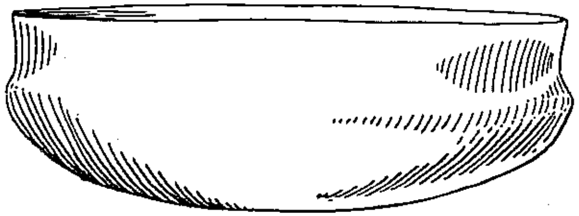

FIG. 18.

EARTHENWARE BOWLS.

Scale, one-quarter.

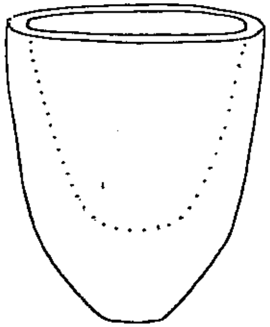

FIG 19.

CRUCIBLES.

Scale, one-half.

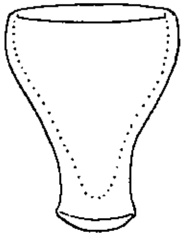

FIG 20.

PLATE XIII.

DAYOB.

Jebel Dayob is a conspicuous hill range about eight miles NW. of Murat. Between the two most prominent peaks, near the southern end, is a deep saddle, and half a mile ESE. of this saddle are a group of ancient huts among low hills of micaceous and felspathic schists. These hills strike roughly north and south with the main hill range, and the strike of the schist coincides, the dip being east. The highest of these small hills is about 150 feet above the plain, and the bearing thence to the highest peak of Dayob is 56° W. of N. Here a vein of white iron-stained quartz can be seen, 3 to 10 feet wide, striking NNE. for a distance of 600 feet, and at the south end of the hill is a small working on this vein 15 feet long by 2 feet deep, the bottom being covered with blown sand. Alongside the trench a small rubbing mill was found and near it some selected quartz, a sample from which gave a trace of gold in the pan. On the west side of the hill, about one hundred yards distant from the central vein, three small outcrops of white quartz were seen, varying from 10 to 30 feet long, but they do not appear to have been worked. On the east side of the hill, at its foot and at about halfway of its length, are a number of pits covering about one-fourth of an acre, which have evidently been made in search of detrital gold. They are in loose drift quartz which appears to have come from the large vein in the hill. This vein ends southward with the hill, but a smaller hill continues about three hundred yards further south, and along the eastern slope of this are about forty to fifty ancient huts, some of which are in an excellent state of preservation, with walls 4 feet high and lintels over the door openings. Some of these are square in plan and measure 12 to 15 feet in the side. East of these huts there is a group of low hillocks (10 to 30 feet) and among these there is a good deal of alluvial working among float quartz, which appears to have come from another white quartz vein from 1 to 4 feet wide, the outcrop of which can be traced in a direction ENE. for a length of 150 feet. In addition to this there are in these hillocks a number of short veins of bluish semi-transparent quartz 1 to 2 inches wide, striking in all directions, and many of these have been excavated by the former workers to depths of from 3 to 5 feet. Samples taken from these small veins panned 1 dwt. of gold per ton. Samples from the larger veins of white quartz gave only a trace of gold in the pan.

ESMAT OMAR.

About three miles below the Bir Towil, the wady of that name enters the Wady Esmat Omar, the course of which is WSW. towards the Gabgabba. A mile westward of the point of intersection, numerous ancient hut remains are seen along the north side of the wady, and on following up the small tributaries coming in from the hills a great many more are found, together with remains of one or two washing tables and several circular grinding mills. The place was evidently a gold washers' encampment, and it is probable that water was obtained from the adjoining wady, for at present there is none nearer than Bir Towil, four or five miles away. No evidence of vein mining could be found, but all the minor wady beds had been turned over in the search for detrital gold. The low hills among which these wadies have their rise are formed of the usual dark fine-textured volcanic rock, and it is probable that auriferous quartz reefs may be found to occur therein, although too narrow perhaps for modern work. The presence of grinding mills and washing tables would seem to indicate that besides alluvial work gold had also been recovered from the stone, and it may be that further search amongst the hills would reveal its source.

FIT-FIT.

Um Fit-Fit is the name given by local Arabs to a group of hills the eastern limits of which are about nine miles west of No. 6 Station on the Sudan Government Railway. The country between the railway and the hills is Nubian sandstone, barren and featureless, with an undulating surface and numerous small escarpments due to wind erosion. The hills, which consist of irregular ridges from 50 to 150 feet high, rise abruptly through the sandstone, and are of the earlier geological formation represented by the metamorphic schists. These rocks here appear to rest unconformably on the grey granite which in gneissic patches makes its appearance here and there within the area of the hills. The group consists of micaceous, talcose and chloritic schists, with numerous calcareous zones—usually metamorphosed into crystalline limestone. Although quartz veins occur in all these rocks, curiously enough it seems to be only in the limestone that they have been worked by the ancients. There is, however, no evidence of vein mining beyond the shallowest of excavations along the outcrop of supposed quartz leaders, as far as such could be reached from surface without removal of the walls. By far the greater bulk of the work done appears to have been for detrital gold, and even this is not extensive compared with "alluvial" areas in other parts of the Concession. The largest group of pits covers an area of about one acre, and the gold sought for appears to have accumulated from the natural disintegration *in situ* of a large quartz reef where it traversed low lying ground, although the undisturbed outcrop of such reef is not at present visible. There is an abundance of quartz in the dumps, and this gives a trace of gold in the pan, although the quartz itself does not seem to have claimed the attention of the former workers; outcrops of similar reefs in high ground have not been worked, and smaller but more promising looking veins in mica schist have similarly been neglected. The small vein workings previously referred to are in a low ridge of coarse saccharoid marble, and below this the whole hillside has been turned over in search of some mineral or metal, leaving the gleaming white boulders of marble conspicuous among the *debris*. The occurrence of these veins in limestone suggests the possibility of galena having been the mineral sought, but the most careful search failed to discover a trace of galena or its decomposition products.

The possibility of gems has also been considered, but it is difficult to see what stone likely to be of use as a gem would occur under these conditions. Among the talcose schists further up the wady there *are* chances of corundum and it is possible that some form of that mineral was an object of search among the ancient dwellers in this Camp; but it would scarcely have been *mined* among the limestones, and in the absence of other evidence we are driven to the conclusion that the presence of gold in the *debris* must be taken to indicate that the mines were worked for gold. This is supported by the remains of ancient grinding mills, and the usual accessories of a gold washer's camp. Such remains, however, are not numerous, and appear disproportionately small to the number of workers who must have occupied the numerous houses seen in this locality. Many of the ancient huts display no evidence (such as mills, &c.), of their former owner's occupation, and in some of them picked specimens of almost pure talc were found which had evidently been selected from small veins of this mineral occurring in the hills. One such specimen was found to contain crystals of apatite, but it is difficult to see how the presence of this mineral could have given it additional value. The whole question of these Fit-Fit workings is rather obscure and deserves further investigation. Such investigation would be much facilitated by the discovery of water in the area, and there seems to be every chance of an attempt in this direction proving successful.

At about the middle of the small group of hills in which the mines occur is a narrow wady which drains a broad area lying to the north. Even at the time of the examination, when any recent rainfall must have been quite out of the question, the wady contained a good deal of herbage, some of which was quite fresh and green. From this and from the favourable configuration of the ground it is considered probable that a well would discover water at a comparatively shallow depth, and this view receives further support in the tradition that in former days a well existed here.

HADAL MOIET.

The Wells of Shigre are situated in a narrow khor within a bold range of granite hills at the south-eastern corner of the Concession, and on the old caravan route from Berenice to Berber. Thirteen miles from the wells, in a direction 20 N. of W., is a small hill range known as Hadal Moiet, which covers an area of about three square miles. In a smaller detached hill, immediately east of the main range, are a number of ancient workings on small white quartz reefs. They are of the usual opencast character, and do not appear to have gone to any great depth. The whole area appears to be auriferous, for there is a good deal of alluvial work in the smaller water-courses around the hill, and the encampment seems to have been a fairly large one. The rock formation is of the usual igneous character, chiefly fine-grained and amorphous, though here and there outcrops of a schistose nature are seen. The situation of these mines being so remote, but little time was given to their examination; and the shallow nature of the work would seem to indicate that they are of minor importance.

IDARIB.

Six miles SSW. of the conspicuous hill range of Kerar Berat, and five to six miles east of the Wady Gabgabba, an extensive mining encampment was found among the low flat hillocks bordering the north-eastern side of the Wady Idarib. The wady takes its name from Jebel Idarib, a prominent mountain peak twelve miles ESE. of the mines. The distance from Murat Wells is thirty-four miles in a direction nearly due east. Unlike most of the mining camps discovered, which are usually in hilly districts, this locality is in the middle of an open plain, the nearest hill of any size being Kerar Birat.

Several groups of huts occur, scattered over an area of quite one square mile ; they are mostly in an excellent state of preservation, and being quite off the usual caravan routes have probably not been despoiled of any antiquities they contained. Most of the huts from their exposed position have been filled with blown sand, and no attempt has been made in the present examination to excavate them or to discover any ancient implements which may exist ; the one item of interest hitherto found is an inscription in Cufic characters on a tombstone dated 307 Muharram = A.D. 918.* The remains of several washing tables and great numbers of circular grinding mills point to the recovery of gold from the stone, and several long shallow excavations may be taken to indicate with certainty that vein mining was conducted here. But very little of the mines is to be seen at present on account of blown sand, and nothing has been done towards clearing them or sampling the veins in their working faces. Many unworked outcrops of vein quartz, both blue and white, were found, having a fairly regular strike NNW., and samples taken from these gave a result in the pan equal to 1 dwt. of gold per ton. As far as could be seen from occasional exposures the containing rock was schistose and associated with diorite, but whether the latter was included or overlaid, or whether the composition of the two was identical could not be determined. In addition to the vein works, large areas of broken ground were seen where the entire surface had been turned over in the search for detrital gold. Altogether a great deal of work seems to have been done here, although little save the huts remains in evidence. Whence the water was obtained for dressing operations in this sandy waste it is impossible to conjecture. The Gabgabba Wady is close at hand, and this receives the drainage of a very large territory ; there may be water in its bed, although as far as could be ascertained there are to-day no wells along its course.

KHABASEIT.

The Wady Khabaseit falls into the Wady Dumera, and this in turn into the Kua which runs north of the Jebel Idarib. At the head of the Khabaseit Wady the bearing back to Idarib high peak is 258° 30′, the distance being twenty miles. Here the wady branches into two main channels running up one to the north and the other to the south of east. In the angle subtended is a group of low black hills striking east and west and about one mile long by half-a-mile wide. Among these hills are numerous ancient workings, the first of which to be described is on the north side and near the angle ; it consists of about a dozen small pits, irregularly grouped, on a number of short quartz "blows" which do not appear to be connected or to form parts of a single disturbed vein. A sample from this quartz panned about one dwt. of gold per ton. Two hundred yards south of this group is a small vein work striking due east diagonally up the slope of a hill, and four hundred yards east of this another similar work apparently on the same line of vein. The latter is about eighty feet long, but very shallow, and the vein cannot be seen. East of this about one hundred yards is a small branch wady fifty yards wide, and beyond that more hills, among which, four hundred yards distant from the last named working, is another small vein work in the same alignment, *i.e.*, due east. Samples taken from the *debris* surrounding these pits all showed a little gold in the pan. About one hundred yards south

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* Acknowledgments to R. K. Douglas, Esq., of the British Museum, to whom this inscription was submitted.

IV.

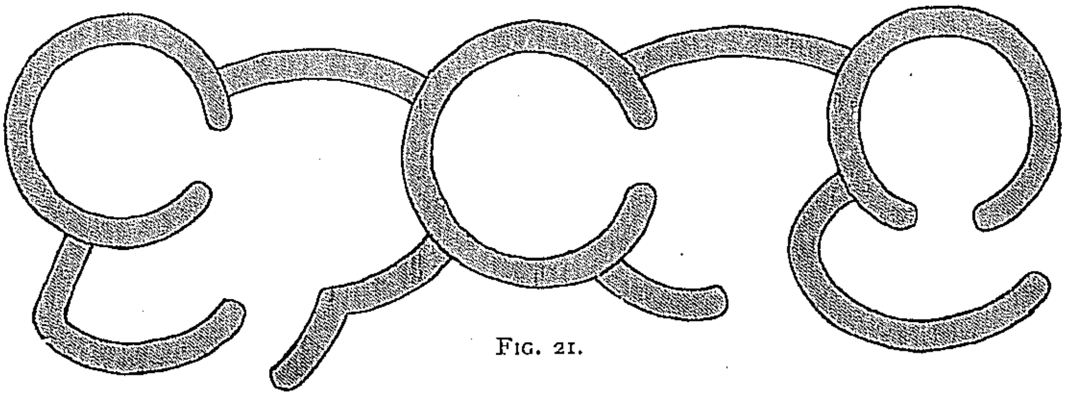


Fig. 21.

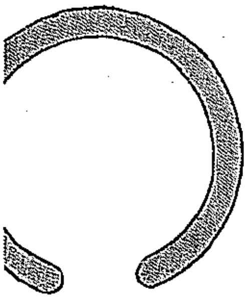


Fig. 22.

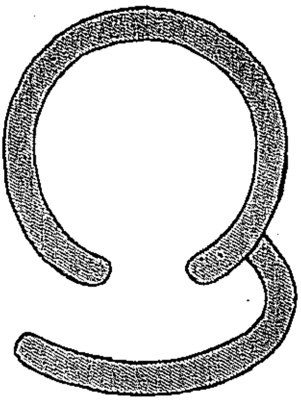


Fig. 23.

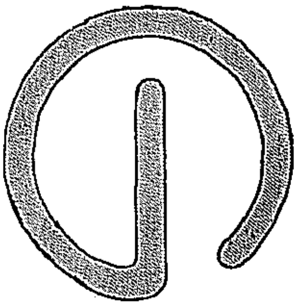


Fig. 24.

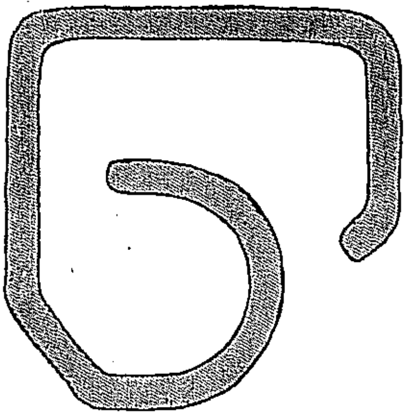


Fig. 25.

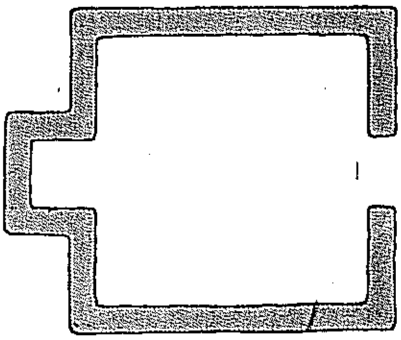
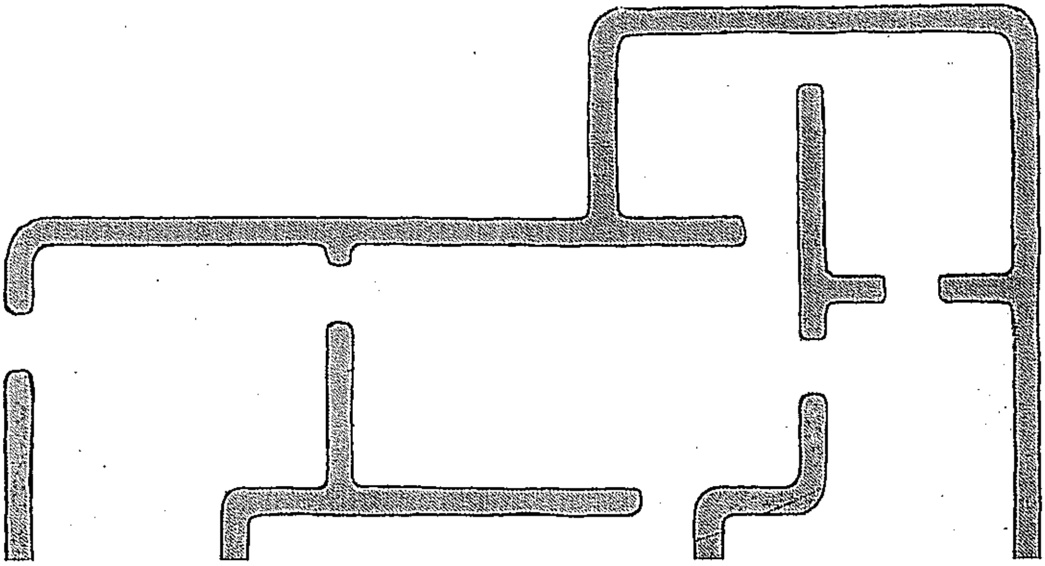


Fig. 26.



of the easternmost pit described is another small trench work, similar in character, but on another vein, and one hundred yards further south a larger working on yet another vein which is wider than the rest, and apparently more productive. This last named working is 150 feet long, with several small shafts opening into a continuous stope beneath. Some of these remain open to a depth of 10 to 12 feet and appear to have gone much deeper, but the sides have fallen in and little of the vein is to be seen. It appears to have been of dark blue, semi-transparent quartz, with a breadth of from two to three feet. A selected sample of this panned 4 dwts. of gold per ton, and one or two stones were found containing visible gold. South of this working and between it and the south fork of the wady are about half a dozen other short shallow workings apparently on parallel veins, which, however, were not examined in detail.

On the north side of the north fork of the wady is another group of ancient mines, the chief of which is a long opencast striking 20 deg. N. of W. for a length of 450 feet and terminating at its western end against the foot of a high hill. One hundred feet up the side of this hill another working begins, but striking NE. with the hill contour; it is 350 feet long, but is almost completely refilled by the talus of the hill. Both these workings are on quartz reefs, the upper one white and the lower blue. The appearance of the latter is especially promising, and the size and continuity of the working may be taken to indicate that it was found fairly auriferous. No outcrop could be seen *in situ*, and as the working has been silted up by natural drainage it was not possible to secure a sample from the vein. Samples taken from the rejected quartz at surface panned respectively 1 and 2 dwts. of gold per ton. In addition to the two large workings described, there are a few others on smaller veins, and the tributary wadies among these hills have been dug all over in the search for gold.

Along both forks of the wady-head at Khabaseit are the remains of numerous ancient huts, which appear to date from two different periods of occupation. The one series is rectangular and closely grouped, two or more rooms frequently communicating, while the other is of the common circular form, separate, and strung out along the wady sides and up the various creeks. The ground plan of a house in one of the groups of the first series is presented in Fig. 27, Plate XIV.; while the general plan of the houses of the second series would be represented in Fig. 22, Plate XIV. Scores of circular grinding mills were found among these ruins, and what is more unusual, several serviceable mullers. Some of the nether stones, of crystalline diorite, were worn to a depth of seven inches, and it is worthy of note that most of these were unbroken, a circumstance which suggests a hurried evacuation. Washing tables, fragments of pottery and glass, and a large number of stone anvils were found, with quartz-breaking hammers weighing from two to ten lbs. Altogether the encampments had in a more than usual degree the appearance of great antiquity, a fact due perhaps to the heavy rains which appear to be of more frequent occurrence in this part of the Concession. Most of the ancient mines have been refilled from this cause, and many of the encampments are almost entirely obliterated by flood water from the hills.

LESEWIT.

These mines are at the head of the Wady Lesewit which runs SW. into the north branch of Wady Tilat Abda, a little above the Tilat Abda wells. The distance from these wells is ten miles, and the distance from Murat Wells is fifty-five miles ENE. The excavations are in the form of continuous trenches along the outcrop of the veins. The principal vein is of quartz, bluish-white and iron stained. Where visible it averages eighteen inches wide including a "dig" of four inches. The strike is N. at the northern end, but going southward it changes to 35 deg. E. of S. The length of the working is 110 feet, but it appears to be shallow, except at the angle, where a shaft five feet long goes to greater depths; the shaft is open to a depth of nine feet and below that full of *debris*. A sample from the "dig" in the end of the shaft panned 1 dwt., and another from the hard quartz panned 8 dwts. of gold per ton. The vein appeared to be a contact vein, the footwall rock being a coarsely granular weathered diorite, while that in the hanging is black, dense, and silicious, having the appearance of a much indurated quartzite. A few yards to the north and also to the south of the trench are two detached circular workings which might have been shafts, but are now refilled with *debris*. One hundred and fifty yards from this working, at 30 deg. E. of S., is the east end of a long trench striking W. 5 deg. S; and two hundred yards farther, on same bearing, the west end of a shorter trench striking N.E. The latter is opened on a small vein of rotton quartzose rock running at right angles to the strike of the country. It appears unimportant, and a sample from it showed no gold in the pan. The other trench is broader and deeper and can be traced 150 feet. It is opened on a similar band of rotton quartzose stone much jointed and iron stained. This is ill defined and bears little resemblance to a reef; but pannings of the stone gave from 1 to 2 dwts., and a scraping from the small nullah below gave a fair show of coarse gold. Along the south side of the vein is a dull green, porphyritic dyke, and it would seem that the presence of gold in the rock is due to the intrusion of this mass rather than to the presence of a true quartz vein. In addition to the above there are one or two smaller workings not sufficiently important to describe in detail. The ancient hut remains are not numerous and only two or three washing tables were seen. No evidence of ancient wells was found and no construction for the storage of water, unless a low semi-circular wall across a small rivulet course can be so explained. The catchment area of this is only 100 feet by 50 feet, but even this has been more than sufficient, for half the dam has been carried away by flood.

MOSEI.

The northern continuation of the Dayob range, already referred to, is known as Jebel Mosei, and from the eastern slope of this hill the Wady Mosei takes its course eastward towards the Gabgabha. About midway between the mountain and the latter wady ancient hut remains begin to make their appearance at the openings of the small wadies running into the Mosei from the north. Though never thickly clustered there are some hundreds of these huts altogether, and the indications point to a considerable amount of mining activity among the low trappean hills lying to the north of the wady. There are numerous "blows" and short veins of quartz to be seen, and in the neighbourhood of these the ground has been turned over in shallow pits, presumably in search of gold, although no actual vein mining was observed. Samples collected from the small water courses among these pits gave a small show of fine gold in the pan.

MUNDERA.

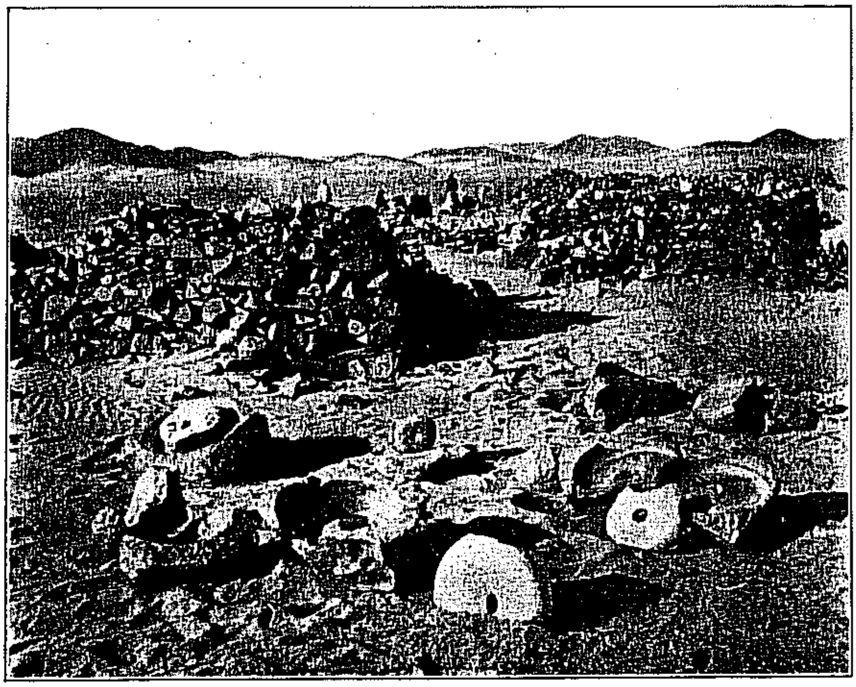
Jebel Mundera is a bold granitic hill mass, standing conspicuonsly out in the plain between No. 6 Station and Murat Wells, and distant about eighteen miles from the former. Three miles SW. of the SW. limits of Mundera a number of ancient huts are seen, skirting the western side of a branch wady running southward to join the Wady Inhawa Ganet. Some of these are in an excellent state of preservation, with walls five feet high. The remains of washing tables were also found and elliptical grinding stones, as well as a few circular mills. Two short trenchworks were examined which had been opened on quartz veins striking NNE. in a bluish-grey micaceous schist, somewhat resembling that seen at Nabardi. Samples taken from these panned from a trace to 6 dwts. of gold per ton, but very little could be seen of the size or extent of the veins. Other small vein works were seen in the vicinity, but the greatest amount of work done seems to have been in search of detrital gold, the presence of which is no doubt attributable to the disintegration of local quartz veins. In this connection it may be well here to take note of a calcareous breccia which is often observed to have been thrown up from these detrital excavations. At first it was considered that the gold of these areas occurred chiefly in this cement bed, but such does not seem to have been the case, for at some places, and amongst them Mundera, this material was quite ignored by the former workers, and at others it has been panned without showing the slightest trace of gold. At Shashu-at-eb, on the contrary, gold was found to occur in the cement in sufficient quantities to deserve attention.

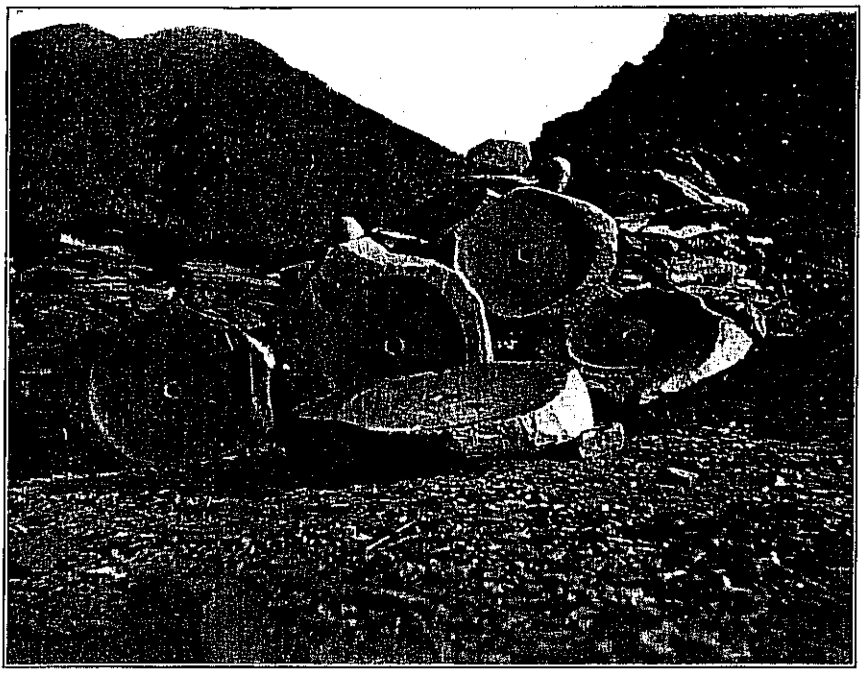
NABI.

The Wady Nabi runs westward to the Gabgabba, passing in its course close under the northern flank of the huge hill mass known as Jebel Nabi. Thence it bends south-westward to meet the Kua flowing westward into the Gabgabba. At the angle where it rounds the hill there are several shallow wells sunk in the wady bed, but the water is brackish, and a permanent supply cannot be depended on. The ancient mines are situated two miles north of the wells, amongst steep schistose hills rising to 200-300 feet. These schists display in a remarkable degree the prismatic "spindley" structure referred to in a previous chapter; the general strike is east and west, but both in this direction and towards the sides the schistose structure is seen to gradually merge into the lithoidal and porphyritic rock of the surrounding hills.

Tbe workings extend over a length of about a mile, and for the purpose of description may be divided into five runs. No. 1, beginning from the west, consists of a few small pits and shallow trenches aggregating a length of about 300 feet. They are almost entirely silted up, and being small have not received attention. These are all on the west side of the branch wady which runs up from the angle of the Wady Nabi. At the east side of the wady bed No. 2 run begins and extends continuously

700 feet in a direction nearly due east, cutting lengthwise through a hill ridge rising to about 80 feet, and terminating in the flank of another hill lying a little south of its course. At places this working remains open to depths of 20 to 30 feet, and a pillar left in one of the stopes showed 18 inches of vein matter consisting of quartz stringers in a hard felspathic matrix much mixed with limonite ; a sample from this panned 6 dwts. of gold per ton. No. 3 run traverses the ridge of the hill in which No. 2 terminates and overlaps it for about 150 feet. It has a total length of 500 feet, but little can be seen of the working as the sides have fallen in. A sample collected from small portions of the vein wherever visible panned 10 dwts. of gold per ton, but the vein appeared to be very narrow. The mean bearing of this run is 8° N. of W. There is every probability that the vein in No. 2 run is a continuation of that in No. 1, and that No. 3 and No. 2 will be found to come together in the hill. No. 4 run, however, is nearly 200 yards to the north of No. 3, which may be due to faulting. It can be traced for a length of 600 feet continuously, through a line of low hills (40 feet to 50 feet) of which the vein once formed the ridge. The system of working was by numerous shafts along the strike, connected by continuous stopes below, the object being to support the sides at surface. Some of these stopes remain open to a depth of forty feet and were entered for the purpose of obtaining samples. The vein remaining in the faces of the stope is small, consisting of quartz branches from one to two inches wide, two or three of which are usually present, and associated with veins of limonite. Samples from the quartz veins panned from 5 to 15 dwts. of gold per ton. The mean strike of this run of workings is 15° N. of W. and the dip 75° S. The fifth and last run is 400 yards east of No. 4, and at the head of a small bay extending up into the hills from a sharp bend in the Wady Nabi above the wells. The excavations strike 10° N. of W., and like No. 4 consist of a series of small shafts connected by a stope below. Where the working traverses a small hillock it remains open to a depth of twelve feet ; but eastward in lower ground it is completely refilled, while westward where the working enters a hill about 100 feet high it assumes the form of a tunnel, of which the roof has fallen in. At the top of this hill is a shaft which evidently communicated with the tunnel below, but the mouth has choked and the working is inaccessible. The entire length is 700 feet, and the stope varies from one to three feet wide ; but the size of the vein could not be determined. It seems to have occurred along a line of fracture, for the footwall is a good deal crushed, although otherwise similar in character to the hanging. A scoriaceous band of limonite accompanies this vein, and although it is not found to carry gold itself, seems to have influenced its productiveness, for the rock in proximity thereto has been stained a purplish red, and it was a similarly tinted quartz which had been the object of selection by the ancient workers. A sample of this quartz collected from among the huts panned 4 dwts. of gold per ton, while a sample from the white quartz, a great deal of which lies about, gave only a trace. Several ancient huts are seen near this last working, as well as mills and washing tables, but by far the greater number occur along the sides of the small wady running down between Nos. 1 and 2 runs, and in the small tributaries thereto. These huts are of the circular type and rarely grouped, but scattered here and there among the hills, as if each occupant pleased himself as to the manner and place of its construction, and mined or washed at will. There is evidence of a great deal of alluvial work below the mines, but whether or not this was contemporaneous with the vein mining it is impossible to say.





Old Quartz Mills, Khabaseit and Nabi.

NABI TANA.

This group of mines is situated seven miles SSW. from Nabi Mines, and about the same distance north of Idarib Mountain. They lie about one mile west of the Wady Nabi, from which they may be easily descried. The principal excavation is situated in a small hill which rises to about 150 feet above the plain, and the working begins just south of the summit. The strike from the south end as far as the top of the hill is due north, but here the working branches, one limb continuing at 5° E. of N. for 130 feet further, while the other extends for 500 feet on a bearing N. 20° E. The working is an open-cast throughout, and continuous except for a pillar here and there where the vein was small or the side was weak. It remains open at places to a depth of 40 feet, and the dip is nearly vertical. The deposit worked is a contact vein, the enclosing rock on one side being porphyritic trap, apparently in the form of an intrusive dyke, while on the western side the rock is banded and of varying texture, the prevailing strike being WSW., and the dip 45° towards the north. The latter is probably of sedimentary origin, but is so far metamorphosed that it is impossible to express an opinion without the aid of the microscope. The vein matter seems to have varied in width from a mere thread up to two feet. Very little quartz is to be seen in the remaining pillars, and it is doubtful whether free quartz was the predominating matrix. The bulk of the pillars consist of kaolinised bands of country rock with small veins of silicious limonite. From the character of the remaining dump and from the (probably) selected stone in the neighbourhood of the huts, it is inferred that the material selected was from the junction of the kaolinized bands with the more silicious portions of the vein. Wherever there was a preponderance of quartz in the vein it has been discarded and remains in the surrounding dumps. The quartz itself is white and veined with limonite. Some of it is coloured green and blue by the carbonates of copper deposited in joints and fractures; but the metal is not sufficiently abundant to admit of the supposition that the vein was worked for copper. Two hundred and fifty yards from the south end of the excavation described, in a direction 25° S. of W., is a second working, but smaller. It is sixty feet long and strikes due north. Eighty yards further north it is succeeded by a similar working, apparently on the same vein; this strikes 12° E. of N. and is 450 feet long. Four yards east of the north end of this working is another which extends 100 feet N. At a bearing 15° W. of N. from the summit of the hill in which the main excavation occurs, and distant therefrom 600 yards, is yet another opencast work on a third vein; it is about sixty feet long, and the discarded matrix carries an unusually large amount of copper carbonates. Samples of vein matter were taken from all these old workings and the pan results varied from 1 to 6 dwts. of gold per ton, the highest results being obtained from the first and last excavations described. In the small wadies just north of the mines are numerous huts of the usual circular character, a few washing tables and circular mills, and the remains of some heaps of tailings, which latter are of a purplish red colour and serve to indicate the character of the vein stuff selected by the former workers. About one hundred of these huts were examined, but without resulting in any find of importance; there is a marked paucity of grinding mills, the few which remain being either broken or worn out, which would seem to indicate that the former workers had abandoned the place at leisure, taking all that was serviceable with them. Sufficient fragments of broken pottery were collected to permit of identification of the prevailing types, which were found to be similar to those employed at Nabi and other surrounding mines.

NASB-EL-HOSAN.

The Wady Gabgabba in lat. 20° 35′ North passes down three-and-a-half miles to the east of a high peaked hill known as Nasb-el-Hosan. Between the wady and the hill, and distant about five furlongs from the former, is a group of pits covering an area 500 yards long by 100 yards wide, the length being in a direction nearly north and south. They have evidently been sunk in search of detrital gold and are very shallow, removing merely the sand and gravel covering the bed-rock, which is here a talcose and micaceous schist. The presence of gold on this surface is probably explained by the occurrence in the schist of numerous small segregation veins of white quartz with limonite veinings. The deposit is evidently a very local one and the character of the detritus precludes the possibility of its having been transported from any great distance. No quartz mining was done here, no mills are seen about, and no hut remains except one or two rude circles of stone which are now almost obliterated. A sample of dirt collected from the pits gave a little gold in the pan, but a panning of the crushed quartz failed to yield a trace of that metal.

OMAR KABASH.

The principal hill of the ranges known as Omar Kabash is in lat. 20° 14′ North and long. 33° 22′ East of Greenwich. It is distant fifty miles in a direct line from Abu Hamed on the Nile, and thirty-five miles from No. 9 station on the Sudan Government Railway. The hill is in the form of a serrated ridge two-and-a-half miles long and rising to 600 feet above the plain. The major axis is about due north, and the hill is formed principally of a band of hard, dark quartzite which rises from a broad formation of metamorphic schists. Numerous other isolated ridges (chiefly quartzite) occur in the neighbourhood, but as is usual in the desert, they are all comprised under the appellation of the principal hill. Two miles west of the hill the Wady Omar Kabash passes on its course north-eastward to the Gabgabba, its source being three or four miles south of this among low hills.

Between the hill and the wady are several patches of ancient alluvial work, increasing in size and frequency towards the wady, and culminating at a small hill just east of the wady in a broad area of shallow pits and trenches which cover quite half a square mile. Around the lower slopes of this hill are numerous ancient huts and a great number of disc mills and fragments of broken pottery. Two miles further south, on the opposite side of the wady and about one mile distant therefrom, is a small range of schistose hills rising to about 200 feet and divided by a narrow valley running north and south. All round the fringe of these hills and in the valley between are innumerable patches of ancient work, and along the sides of the valley many hut remains of a similar character to those already mentioned. From here northward, for a distance of six or seven miles and extending over a breadth of from half a mile to one mile, are an immense number of ancient mining sites, and it is not too much to say that for the whole of this distance quite half the entire surface has been turned over in the search for gold. At intervals throughout this distance, where hills occurred or where a little rising ground afforded immunity from a possible inundation, are clusters of huts and ancient mining camps.

The workings are all of the same character and appear to have been made in search of detrital gold; but the conditions observed indicate that this has not been transported from a distance by ordinary alluvial agencies, and it is practically certain that the deposit has resulted from disintegration of the local rock. In this great numbers of quartz veins occur, and except where the enclosing rock rises into small hills the quartz shed therefrom is sufficient to cover the whole surface, sometimes to a depth of several feet. In no case observed had there been any attempt to mine these veins below the surface, and in comparatively few instances had the actual outcrop been attacked. The great bulk of the workings consist of shallow pits sunk through a stony *debris* to the underlying shelf on which the gold seems to have occurred in a thin layer of finer pay dirt. The huts seen are of the usual circular type with the difference that an internal dividing wall as shown in Fig. 24 (Plate XIV.) was a common feature. They were also usually grouped in clusters of five or six, as if occupied by families or small co-operative gangs. These houses have, in a more than usual degree, the appearance of great age and the grinding mills are often deeply weathered.

OM NABARDI.

The Om Nabardi Mines are situated on the western side of the wady of that name which flows southward from the slopes of Jebel Rafit into the Wady Murat. The distance from Murat Wells is ten miles in a direction WNW. The distance from No. 5 station on the Sudan Government railway is twenty-four miles, and from No. 6 station twenty-eight miles. The wady at this point is fifty yards wide and is enclosed by black cindery-looking hills rising to about 150 feet. Here and there a lighter coloured hill is seen where large quartz reefs occurring therein have contributed to the talus on its slopes. These hills are absolutely bare of vegetation, but in the wadies there is a scanty growth of camel-thorn. The mean elevation is 1,300 feet above the sea. The prevailing rock is a coarsely laminated schist, micaceous and chloritic, sometimes talcose, and less frequently with much actinolite. Associated with this is a harder and less altered rock which is more distinctly igneous. The one seems to merge into the other, but at places dyke-like bands of the latter are seen to traverse the schist, although such apparent dykes have not been found to penetrate the reefs. The mean strike of the foliation is ENE., and the dip towards the south. This also may be taken as the mean strike of the quartz reefs, although outcrops are seen striking at all angles. The reefs are as irregular in size as in strike, varying from a mere leader up to twenty feet, the larger developments forming the backbone of several of the hills. They appear to be fairly continuous and with little difficulty outcrops can be traced for lengths of 1,200 to 1,500 feet.

from the abundance of iron-stained quartz which covers its sides. There are several outcrops of quartz in the hill, all of which have been worked by the ancients, and still pan fair shows of gold. 2,000 feet SSE. of the Twin Shafts two parallel reefs are seen, striking NNE., and separated by a distance of 150 feet. Both contain ancient workings, and the quartz, though narrow, appears to be very persistent and gives excellent shows of gold in the pan.

In a saddle between the hills south of Hill Reef hundreds of elliptical rubbing mills were found, and down the eastern slope therefrom several washing tables and heaps of tailings. Below this again numerous hut remains with circular grinding mills, and in proximity thereto remains of furnaces and scoriaceous slag. This was evidently the chief centre of activity, but for miles around collections of these ancient huts are to be seen with similar evidences of their former owners' occupation. One such camp, a few hundred yards north of the mines, had been entirely destroyed by a later incursion of prospectors, who appear to have ransacked all the huts and turned over the whole area of the encampment in search of something—detrital gold or buried treasure. With the possible exception of the central mine, most of the work done in this neighbourhood seems to have been the result of individual effort rather than that of organised gangs ; indeed it is impossible to reconcile the general appearances at Om Nabardi and the scattered character of the ancient habitations with any system of forced labour or condition of captivity among the operators. It is possible, however, that the mines have known two periods of exploitation, and that all traces of former close encampments have been obliterated by the later occupation of the Arabs.

ROD-EL-USHAL.

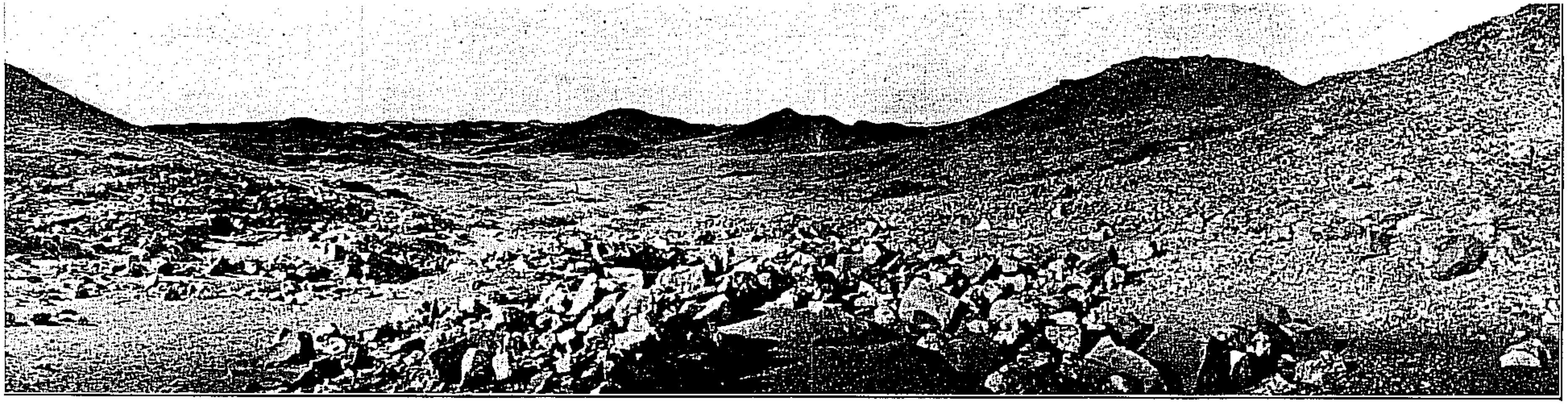
Bearing 147° from No. 6 station of the Sudan Government Railway, and distant four-and-a-half miles therefrom, is the northern end of a long, low range of hills striking first south-west and then southward, parallel with the railway. This is known to the Arabs as Rod-el-Ushal; the southern continuation being better known as Jebel Kafayeb. The rock forming the main range is coarse-grained granite, but it appears to be directly succeeded on the west and north-west by a dense black basalt which is probably associated with the usual metamorphic schists; the present surface, however, is a stony plain. Bordering the hill at a distance of about a mile, and at the edge of the plain, is a belt of auriferous ground about three miles long by one mile broad, almost the whole of which has been turned up in a multitude of pits and shallow trenches by ancient workers in the search for gold. This was contained in a fine gravel bed lying directly on the bed-rock, and had its origin probably in the numerous quartz reefs seen outcropping here and there among the pits. No regular main reef was seen, and the gold does not appear to have come from the hill itself, for the ground immediately bordering it has not been disturbed.

Pannings from the worked dumps having failed to disclose the presence of gold, some doubt was at first experienced as to the object of the workers' search. With a view of settling this point eight trenches, each about 100 feet long, were made at different points and carried to the bed-rock. Of the forty samples taken from these trenches, those taken from the patches of the gravel deposit which remained never failed to show gold in the pan, while those taken in ground which had been already worked yielded no trace of that metal. This proves beyond all doubt not only that the precious metal was the object of search, but that the search was conducted in a most efficient and thorough manner. The suggestion as to the probable source of this gold also finds support in the fact that of eight samples taken from reef encountered in the trenches four yielded a small show of gold.

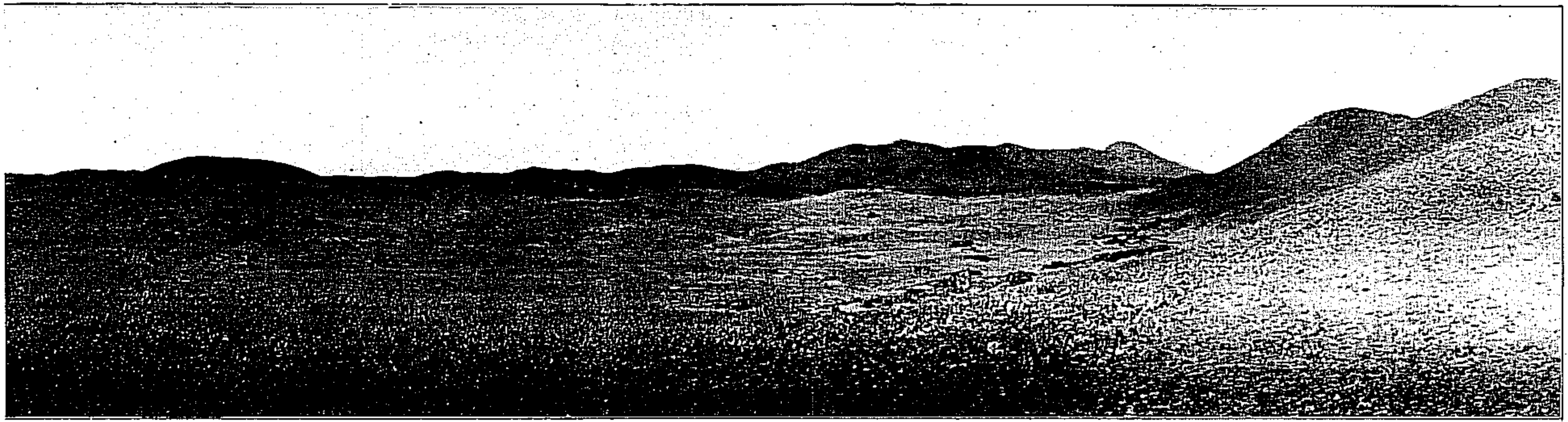
SHASHU-AT-EB.

Jebel Hajarreib is a trigonometrical hill station situated in lat. 21° 43′ 35″ N. and long 34° 8′ 53″ E. From the south-eastern slopes of this hill range, the Wady Shashu-at-eb takes its course eastward to meet the Wady Ga, which flows north to the Allaki. Near the head of the wady, where it first emerges from the hills, an ancient encampment of from 150 to 200 huts is found, covering an area of 600 yards by 300 yards. Several circular quartz mills were seen, some of which are within the hut walls and in the position in which they were last used. Washing tables were fairly numerous and in a fair state of preservation. Potsherds were abundant, the predominating type being Fig. 9, Plate XI. The rock formation is of the fine textured and porphyritic variety described in the second group of igneous rocks, and in this occur a great number of small quartz veins which have been worked to shallow depths all over the area. The chief excavation, however, consists of a long trench striking NNW. The total length of this is 450 feet, but there are two breaks in its continuity, the three sections being somewhat out of alignment. From the size of the dumps it would not appear to be more than twenty to thirty feet deep, but the trench is in low-lying ground, and much of the *debris* may have been washed away; the trench itself is quite refilled. A good deal of white opaque quartz remains, and appears to have been discarded by the workers, who favoured a more transparent quartz with heather-red tints. Occasional stones of the latter were found at the trench as well as among the huts, and samples taken from these panned respectively 10 dwts. and 2 ozs. of gold per ton. A calcareous (kankar) conglomerate containing pebbles of quartz was also found in the trench dumps, and a sample of this panned 8 dwts. of gold per ton. A selected sample from the smaller veins just referred to gave a show estimated at 3 ozs. per ton.

About a mile west of these mines a second group of huts was found; the hills here are closer and the huts line the sides of a small fork from the Wady Shashu-at-eb. About a hundred huts were observed here, with numerous circular mills and an abundance of potsherds, also fragments of blue and opal-tinted glass. Small heaps of broken quartz were found among the huts, mostly white; but a few stones of the heather-tinted variety (evidently the object of selection) were found, and these panned a result equal to 30 dwts. of gold per ton. Except small pits sunk for detrital gold no working of any size could be found in the neighbourhood of these huts; but about one-and-a-half miles further westward among the hills two trench workings were found which had evidently been the source from which the quartz was obtained. The first was seventy-five feet long, striking NNW. across the top of a small hill, and the second 180 feet long, striking NW. up the eastern slope of a hill 200 feet high. The enclosing rock is of the same igneous variety (here porphyritic), and the trenches seem to be along the line of contact between this and a more basaltic rock which may be intrusive. Although partially refilled, it could be seen that the workings were certainly not more than a few



Ancient Dressing Floors at Om Nabardi.



Ancient Mining Camp at Tana Shaib.

feet in depth, and a considerable proportion of the quartz produced remained at surface. This was white, with included hornblende and veins of limonite, and a fair sample therefrom panned only 1½ dwts. of gold per ton. A sample of purple-tinted quartz, however, collected with some difficulty, gave a result estimated at 2½ ozs. of gold per ton. On the hill-slope below the veins are a number of irregularly-disposed pits, which appear to be shoding holes after detrital gold.

TANA SHAIB.

The wady Tana Shaib, flowing from the SE., joins the Gabgabba in or about Lat. 21° 15′ N. About eleven miles up the wady there is a water hole in its sandy bed, and overlooking this on the east side is a high rounded hill, which is the most prominent peak of the Tana Shaib range. About four miles from the hill, at a bearing 40° S. of W., is a very extensive old mining encampment, situated in a broad hollow amongst low hills. The principal rock formation is undoubtedly igneous ; but here and there in the low lying ground a schistose and slaty structure is observed which suggests the possibility of associated sedimentaries. The auriferous deposits worked by the ancients consist each of a network of small silicious veins occurring in a band of decomposed felspathic rock which is coloured brown from the presence of iron oxide. The veins vary in size up to three inches, some being entirely of quartz, some of silicious hæmatite, and some of earthy limonite. Gold occurs in all, but more particularly in the quartzose veins, a sample from which panned 6 dwts. of gold per ton, while a picked sample of almost clean quartz gave a result equal to half an ounce. There is a good deal of carbonate of copper to be seen in the broken stone, and the appearance of the waste heaps generally is indicative of the presence of copper in appreciable quantities ; but there is little doubt that the mines were worked for gold, and the ancients do not appear to have recognised the baser metal or to have considered it worth saving as a bye-product of the mines.

The mines are in the form of continuous trenches along the outcrop ; eight of these were counted, the longest being 600 feet long, and the shortest 50 feet. They occur in a small hill (70 feet) on the western side of the hollow, and the mean strike is NE., conforming to the schistose lamination and to the general contour of the hill. Most of the workings have been refilled by natural agencies to within three or four feet of surface, but none of them appear to have been very deep, although at one or two places circular hollows were observed, as though a shaft had gone to greater depths. About 200 yards east of the trenches the encampment begins, and this covers a very extensive area, and comprises an unusually large number of huts, some of which are rectangular and grouped together in small rows of ten or twelve. Strange to say the number of grinding mills is comparatively small, and elliptical mills for the preliminary crushing are almost entirely absent. The tailings heaps, too, are insignificant compared with the size of the encampment ; but this may be accounted for by denudation. There is no pasturage in the neighbourhood and no permanent wells exist at present, so that it is difficult to see what, except a mining industry, could have attracted and maintained so large a community. The workings here described do not appear large enough to have given employment to so many people, and it is probable that further search among the hills will reveal the presence of more extensive mines.

TERFOWI.

In the Wady Terfowi, the situation of which has already been given, is a well-known permanent well, the Bir Terfowi, and two miles below this, at an angle in the wady, is a very ancient encampment consisting of over one hundred huts all closely grouped in two main blocks, with a broad road between. The houses are rectangular, and vary from ten to twenty feet in the side: some of the walls are still standing to a height of four or five feet, and many of the doors are lintelled. Circular grinding mills were seen in some of the houses, and the place has the appearance generally of an ancient mining camp. Search among the hills resulted in the discovery of a few shallow trench works, but no mines of any magnitude were seen and no reefs which appeared to be worthy of attention. A great deal of alluvial work had been done in the beds of the smaller wadies running into the Terfowi from the north, and in many cases the small rivulet courses in the hillside had been followed almost to the summit. The rock formation of this locality is chiefly igneous, with bands of metamorphic schists resembling those seen at Nabi and Om Nabardi. The granite is not far distant, and altogether the conditions may be considered favourable to the occurrence of auriferous reefs, although none of any importance happened to be discovered in the present survey.

TILAT ABDA.

Between the Bir Tilat Abda (21° 20″ N. 33° 30′ E.) and the Nabi Mines, distant in a direct line about thirteen miles, are a number of small mining works with their attendant groups of huts and washing tables. They occur in a range of low trappean hills forming the watershed between the Wady Nabi and the Wady Dom, and the mines consist chiefly of shallow open trenches along the outcrops of short irregular veins of white quartz. A good deal of alluvial work has also been done in the beds of the small wadies in the immediate neighbourhood of the veins, but the worked areas are small, and are too numerous to be described in detail. No extensive vein work was seen, and it is considered improbable that any large and continuous reefs will be found to occur in this particular formation. The huts are of the usual circular plan, and are scattered here and there along the wady sides for a distance of some miles.

UFFAIN.

See groups described under head Abu Dalala.

WADY DOM.

See groups described under head Tilat Abda.

WADY ROMEIT.

The distance from Bir Tilat Abda to the mines of Tana Shaib by the camel track is twelve miles. The route is rather circuitous, and at eight miles from the former station passes close to the mines of Romeit. These are situated on the right bank of the wady of that name, amongst low hills (80 feet to 100 feet) which stretch away in increasing height to the range of Tana Shaib. The ancient huts, about eighty in number, are situated on both sides of a small tributary wady, the whole bed of which has been turned over in the search for gold. No vein workings were seen, but at places shallow excavations had been made continuously up the hillside, and these appear to have followed the course of a former line of drainage. These lines of drainage in turn have probably been directed by more felspathic bands in the igneous rock formation, which, becoming more freely kaolinized, have offered less resistance to erosion. In these kaolinized bands small veinings of quartz are sometimes seen, but it is uncertain whether these have been the source of the gold or whether it has resulted from the decomposition of the pyrites which is freely distributed in small crystals throughout the rock. The gold appears to have been confined to the area of the hills, for the larger wady bed has not been worked, and it is clear that such gold as the place produced must have resulted from disintegration of the local rocks. Amongst the ancient huts several circular grinding mills were found, and the remains of one or two washing tables with their accompanying tailings' heaps. Pannings from the heaps produced a trace of gold, while pannings taken from the detritus of the hill panned about 1 dwt. per ton.

(B) MODERN.

OM NABARDI MINES.

The position of the reefs and the extent of the ancient workings thereon have been described on page 49. The work of re-opening the old mines was begun in November 1901. Some of the smaller workings were entirely cleared of *debris*, but in the larger stopes it was found more expeditious to spill through the stuff until the working face was reached, which enabled samples to be taken from the reef at points where the ancients had left off work

On the Hill Reef the face was thus exposed and sampled at eight points, the depths varying from 10 to 70 feet. The quartz varied in size from a few inches up to three feet, and the average value (omitting one sample which was exceptionally high) was slightly over half an ounce of gold per ton. It is on this reef that the Twin Shafts

70 feet and was continued to a depth of 120 feet on a reef from 6 to 8 inches wide, the panning tests of which varied from 15 dwts. to 2 ounces 10 dwts. of gold per ton. At 120 feet the reef folded into the hanging wall and a cross-cut was driven 12 feet southward across the fold, when the reef was found to resume its normal course. A level was driven on it eastward for 30 feet from the cross-cut and the reef averaged 6 inches wide with an average value of half an ounce. In the fold it averaged 9 inches wide and the average value was one ounce. The 120 feet level has also been driven west of the shaft 110 feet, the reef varying in size from 3 inches to 1 foot and in value from 5 dwts. to 5 ounces of gold per ton, the average value being 1½ ounces. The sinking of Central Shaft is being resumed on its former lines with the object of discovering water, and the total depth is now 150 feet from surface.

Western Shaft.—This is situated near the centre of the run of ancient workings on Wave Reef. It passed out of the workings at 60 feet from surface, and was continued to a depth of 125 feet on a reef varying in size from 6 to 18 inches, and in value from 5 to 15 dwts. of gold per ton. At the depth named levels have been driven east and west on the reef 70 feet and 120 feet respectively. In the former the reef was small and poor, but a cross-cut southward from the present end has revealed a reef 3 feet wide, which pans from 3 ozs. to 5 ozs. of gold per ton. This appears to be a distinct branch from that followed in the shaft. The reef in the western drift varied from 4 inches to 4 feet in width, and assayed from a few pennyweights up to 3½ ozs. of gold per ton, the average value for the whole length being 1 oz. 2 dwts. 12 grs.

Air Shaft.—Ventilation at West Shaft became so bad that it was found necessary to sink another shaft in order to proceed with the work. A site was selected 120 feet further west along the outcrop, and a small air-shaft has been sunk 110 feet and communicated with the western drift. The reef in the shaft averaged about 6 inches wide, and the value varied from 1 oz. to 2½ ozs. of gold per ton.

Cross-cut.—In order to prove to some extent the nature and value of the quartz reefs seen in Red Hill (see page 50), a cross-cut has been started at the foot of the hill and driven northward into it a distance of 150 feet. It has disclosed a few small leaders of quartz which are auriferous, but has not yet intersected anything corresponding to the massive outcrops seen at the summit.

Wells.—Several shallow wells have been sunk in the beds of the wadies adjacent to the mines, but without the desired result. Five miles from the mines, at Jebel Rafit, a deep well was sunk to 120 feet, and discovered a flow of water which, without cross-cutting the strata, yields 2,400 gallons per day.

Borehole.—A 2-inch diamond drill-hole has been put down at a favorable spot about 2½ miles from the mines in order to ascertain the ground-water level of the locality. It was sunk 260 feet, and at 246 feet struck water, which has since risen to 228 feet from surface.

SUMMARY OF WORK.

Work.	Clearing.	Sinking.	Driving.	Crosscuts.	Total.
Eastern Shaft	...	160	210	22	392
Central Shaft	...	150	140	12	302
Western Shaft	...	125	200	10	335
Air Shaft	...	110	...	...	110
Hill Crosscut	...	...	...	150	150
Deep Wells	...	120	...	...	120
Shallow Wells	180	...	...	...	180
Trial Pits in Ancient Works	555	...	...	...	555
Total feet	735	665	550	194	2144

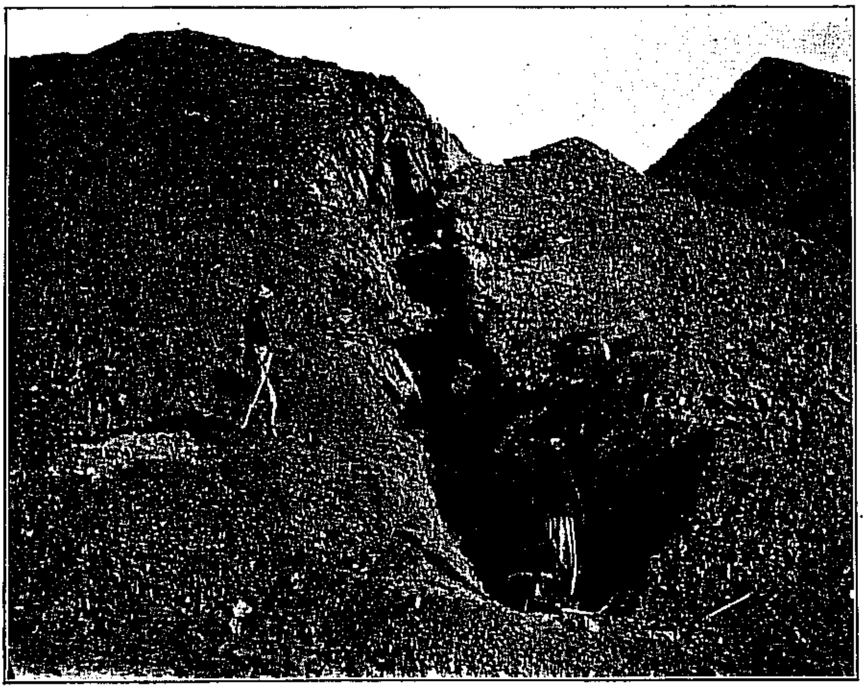
NABI MINES.

Particulars of the surface features and the extent of the ancient workings at Nabi will be found on page 45. The work of reopening the mines was commenced in May 1902, and suspended (temporarily) in May 1903. The actual working period under review is about one year.

The ancient excavations were all more or less filled with *debris*, but no attempt was made to clear them, as it was decided to at once get beneath the limits of the former workers before making any effort to examine the vein, since a mere sampling of the former working faces would necessarily be inconclusive.

The three central runs, Nos. 2, 3 and 4, were selected for trial. On No. 2 run a diagonal shaft or *chiflon* was sunk on the course of the vein, partly through pillars and partly through old workings, to a depth of 102 feet. The principal one of these pillars contained vein matter 14 inches wide, worth 17 dwts. of gold per ton. The shaft finally got into unwrought ground at 88 feet, below which point the vein averaged 10 inches wide, with an assay value of less than 1 dwt. A cross-cut was driven south from the bottom, and at 12 feet intersected another branch of the vein, which was 2 inches wide and assayed up to 10 dwts. This was driven on eastward a distance of 44 feet, and averaged 10 inches in width, with an average value of 9½ dwts. One sample from this vein panned as high as 20 ozs. of gold per ton.

Three hundred feet east of this shaft the same run is further tested by an adit level driven 160 feet along its course. For the first 140 feet the vein averaged



Ancient Works and

Ancient Mining Camp at Nabi.

1 foot 6 inhes wide, and the average assay was about 1 dwt. of gold per ton. It then began to pinch, and the width in the present end is less than an inch. Eighty feet from the mouth the adit intersected an old working, which was only 4 feet long in the back of the drift, but lengthened to 20 feet below. This was cleared up and the working faces sampled. A little below the drift the vein was 6 inches wide and panned 5 ozs. of gold per ton, while in the bottom (17 feet below the adit) the width was 1 foot, and the value 1 oz. 10 dwts. A crosscut southwards has been started from the end of the adit with the object of opening the vein in No. 3 run and thus ventilating the mine.

To prove No. 3 run another adit was driven north-eastward into the flank of the hill near its western end. It intersected the vein at 52 feet and has been driven a further 75 feet along its course. Where first seen the vein was very small, but a few feet further on it opened out to 2 feet 9 inches wide, and it has continued to vary considerably in size to the present end where it is 2 feet 6 inches wide. For the greater part of the length traversed the value is low—about 1 dwt. per ton—but near the end there was a remarkable improvement, the estimated value being 1 oz. of gold per ton over a width of 2 feet 9 inches. The vein seen in No. 2 and No. 3 run usually carries well-defined walls, but consists principally of country rock much kaolinized and traversed by narrow bands and veins of dark brown quartz and limonite ; these small bands carry most of the gold, the remaining portion being comparatively barren except for a slight enrichment along the walls.

No. 4 run, being in lower ground, has been opened by a shaft sunk on the course of the vein. For the sake of safety a bar of unwrought ground was selected, and as might be expected the vein occurring in this bar was small and of little value. At 75 feet from surface levels have been driven east and west on the course of the vein a total distance of 113 feet. The vein formation followed in the drivage consists of three very small but well-defined leaders, between which the country rock is scarcely altered. These leaders are evidently fissure planes along which a certain amount of movement has taken place, resulting in the formation of smooth surfaces and crushed walls. Sometimes there is little more than the lines of fracture to be seen, while at other points they open out to an inch or two and contain a little quartz. Practically all the gold is contained in these small fissures, occurring in crystalline form and as an incrustation upon the sides. Samples taken from the fissure may assay anything up to 50 ozs. per ton, while a fair sample broken over the full breadth of the end will yield, perhaps, 5 dwts. The sampling record shows an average of 3 dwts. per ton over a mean breadth of 3 feet, and results varying from 1 to 30 ozs. per ton from the leaders. There are probably several other auriferous fissures besides the three carried in the drift, for a cross-cut driven into the hanging wall (south) a distance of 16 feet 6 inches has revealed *three* others and the end of the cross-cut is still in rock of the same character.

Wells.—Three or four shallow wells have been sunk in the bed of the Wady Nabi, and one of these discovered a little water ; but it was brackish and unfit to drink, and the supply is too small to permit of the installation of a distilling apparatus. No attempt has been made at deep well sinking, and the camp has been supplied from Tilat Abda, about fifteen miles away.

SUMMARY OF WORK.

Work.	Clearing.	Sinking.	Driving.	Cross-cutting.	Total.
No. 2 Run—					
Chiflon	...	102	44	12	158
No. 1 Adit	...	...	160	20	180
Air Shaft	...	30	...	...	30
Old Workings	17	...	...	...	17
No. 3 Run—					
No. 2 Adit	...	...	127	10	137
No. 4 Run—					
Shaft	...	75	...	...	75
75-feet Levels	...	...	113	27	140
Pits in Old Workings ...	100	...	...	...	100
Shallow Wells	...	100	...	...	100
Total feet	117	307	444	69	937

NABI TANA.

This mining area is situated 7½ miles SW. from Nabi, and is described on page 47. The principal excavation made by the ancient workers has a length of over 500 feet, and in order to see something of the vein which they worked, five pits were sunk through the *debris* as far as they could safely be carried without timbering.

No. 1 Pit is 30 yards from the north end of the working; it is 36 feet deep by 10 feet long, and appears to have reached the bottom. The vein is from 2 to 10 inches wide (average 6 inches) and the value is 10 dwts. of gold per ton.

No. 2 Pit is 30 yards south of No. 1. It is 15 feet long by 15 feet deep, but has not reached the bottom of the working. The vein seen in ends and pillars averages 5 inches wide, and the value is 5 dwts. of gold per ton.

No. 3 Pit is 15 yards south of No. 2. It is 50 feet deep by 8 feet long, through old workings all the way. There is solid ground at bottom, which may or may not be a pillar. In this the vein was 5 inches wide, and the value 2 ozs. of gold per ton.

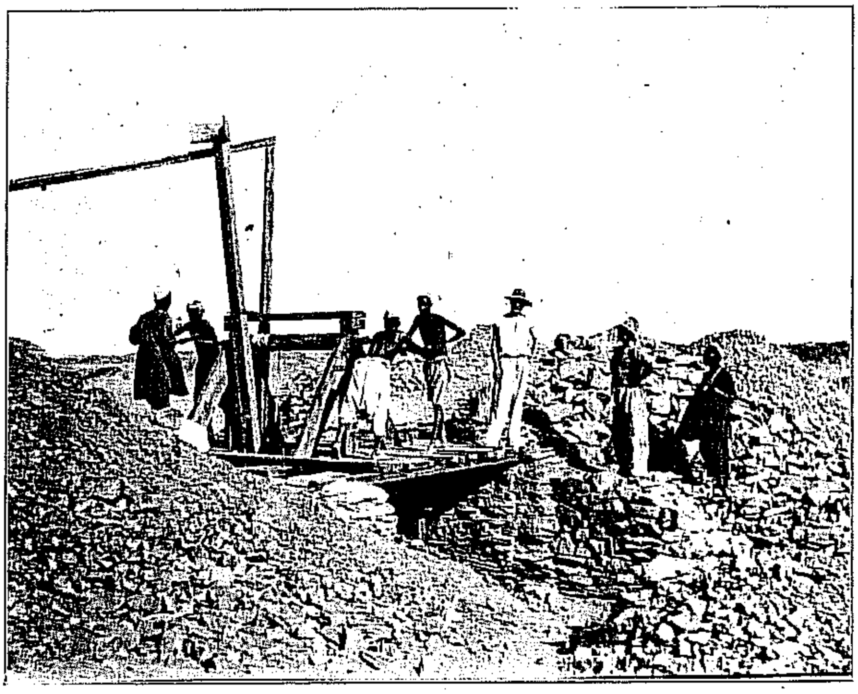
No. 4 Pit is 40 yards south of No. 3. It is 35 feet deep by 8 feet long, and in old workings all the way. The vein at bottom is 2 inches wide and worth 15 dwts. of gold per ton; but a sample of selected stone from this pit, collected at surface, panned 8 ozs.

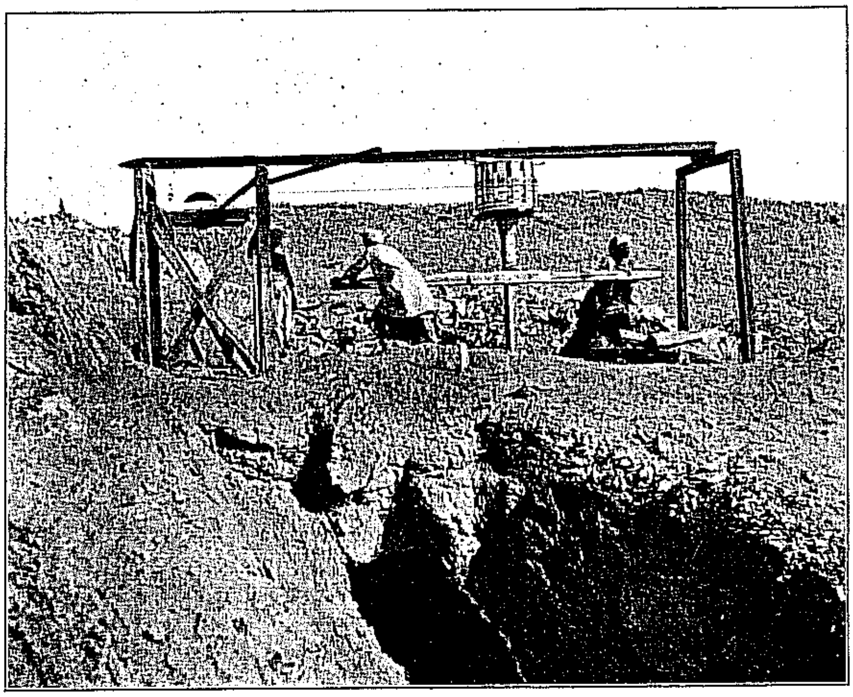
No. 5 Pit is 15 yards south of No. 4. It is 22 feet deep by 10 to 12 feet long, with solid ground at the ends. The vein is from 1 to 2 inches wide, and the value is 10 dwts. of gold per ton.

The vein in all these pits consists of a brownish iron-stained deposit which frequently carries a little drusy quartz, filled with ochreous powder. It is often accompanied by a band of silicious limonite in which visible gold is sometimes found, but as a rule the gold seems to be contained principally in the finer ochreous portion of the vein.

SUMMARY.

Work.	Depth.	Size of Vein.	Value.	
	Feet.	Inches.	ozs.	dwts.
No. 1 Pit	36	6	—	10
No. 2 Pit	15	5	—	5
No. 3 Pit	50	5	2	0
No. 4 Pit	35	2	—	15
No. 5 Pit	22	2	—	10
	158	4	—	16





CENTRAL SHAFT AND EAST SHAFT, OM NABARDI.

PART IV.

ECONOMICAL.

WATER.

There is little doubt that the want of an adequate water supply presents the chief obstacle to any scheme for the modern exploitation of these mines. But it is not an insuperable one, and there are other mining districts now being worked successfully where the conditions were almost, if not quite as bad as in the central Etbai. There are three possible sources of supply to be considered: first, ground water; second, rainfall impounded by dams; and third, the Nile.

In considering the first, the present wells and water holes may, with the possible exception of Murat, be dismissed at once. They are in most places merely holes dug in the sand-filled beds of wadies where water has collected either by reason of a bar of rock across its course or through a wash-out in its rocky bed caused by a sudden bend. Some of them are "permanent" in the sense that they are never wholly dry, but even the best of them after watering a large caravan take many hours to refill. At Murat the conditions are more favourable, inasmuch as the storage capacity of the soakage is so great that all ordinary requirements are met without sensibly lowering the level of the water. A small amount of water, perhaps 1,000 to 2,000 gallons per day, might be drawn from this source without serious depletion of the reservoir, but every gallon drawn leaves a gallon less in the wady bed; and as there is no reason to suppose that a hidden spring exists, its renewal would depend entirely on the very scanty and uncertain rains.

It becomes necessary, therefore, to seek some more permanent and deep seated source. The ground-water level of a country may be anywhere between surface and sea level, and in this Concession it would seem to be from 100 to 300 feet below the surface. Many ancient wells in the Egyptian desert are said to have reached a depth of 200 feet, and at the Hamesh mines in Egypt, owned by this Syndicate, water has been found at 150 feet from surface. At other mines recently opened in that country it is reported that there is even a difficulty in coping with the water at less depth.

To come nearer home, water was discovered on the route of the Sudan Military Railway* at a depth of 75 feet in sufficient quantity for all requirements of the line between Halfa and Abu Hamed. This is within the limits of the Concession, and 300 feet higher than the position of Nabardi Mines.

A well sunk at the mouth of Khor Um Gerrinfat, one of the ravines in Jebel Rafit, struck water at 114 feet, and at 120 feet the flow had reached 2,400 gallons per day without any cross-cutting of the strata. This is but five miles from Nabardi. Two and a half miles from Nabardi a bore-hole has been put down 260 feet, and water found at 246 feet, which has since risen to 228 feet from surface. This would indicate that at a reasonable depth a permanent supply of water does exist, and that growing requirements can be met by a multiplication of wells over an extending area. The cost of such wells is not excessive, and the average may be placed at £2 per foot down to depths of 200 feet. To this must be added the pumping charges and the cost of plant.

As regards the utility of any scheme for damming the mountain ravines, the first consideration is the amount of rainfall. A good example of the practicability of such a system under conditions of prolonged drought is afforded by the town of Aden where the rainfall is at least as small as in the Nubian desert. Here the entire wants of the community were for many years supplied by means of artificial reservoirs which are said to have had a total capacity of 30 million gallons. It is unfortunately impossible to estimate with any degree of accuracy what the annual rainfall on Jebel Rafit really is. The showers of October 1902, and May 1903, each lasted for some hours, and certainly could not have guaged less than an inch, probably a great deal more. The area of the hills is approximately 150 square miles, and the number of "khors" by which they are drained is ten, which gives us an average drainage area of fifteen square miles each, or, allowing one-third for external drainage not entering the ravine, an average catchment area of ten square miles for each ravine. An inch of rain on ten square miles equals 145 million gallons, of which, allowing 75 per cent. for absorption, 36 million gallons should be available for storage. One quarter of this amount impounded annually would be sufficient for all requirements of an ordinary mine.

A reservoir to hold 10 million gallons of water would require to be of 60,000 cubic yards capacity; and taking the mean breadth of the ravine at 100 yards, and its fall at 1 in 50, the height of dam necessary to give this storage would be 15 feet above the surface of the silt. It is probable that a firm foundation would be found within an average of 9 feet below the present surface, making the total height of the construction 24 feet. With a mean thickness equal to half its height, such a dam would contain approximately 3,300 cubic yards of masonry, the cost of which would probably be about £3 per cubic yard. To this must be added the cost of excavation, and the construction of an efficient by-wash. The evaporation from such a reservoir as here described would probably amount to ¼-inch per day, or about half the entire contents in the year, leaving 5 million gallons per annum available for distribution. This, at first sight, seems a simple and inexpensive solution of the water difficulty; but unfortunately the chief factor in such a scheme—the rainfall—must remain uncertain, and there is also the tantalizing possibility of rain falling at any or all the khors except the one selected for the dam.

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* Now the Sudan Government Railway.

To pump a water supply from the Nile, the most favourable point of departure would be at Abu Hamed, although the distance thence to Om Nabardi is 132 miles, as against 112 miles from the cataract at Halfa. The height of the river at Abu Hamed being 950 feet as against 450 feet* at Halfa, the relative gain from the higher station is nearly 50 per cent. of the entire load; the line of watershed to be surmounted (1,700 feet) being about the same in either case. The mean height at Om Nabardi may be taken at 1,300 feet. Although a little more circuitous than it might otherwise be made, it is recommended that the line of pipes should follow the course of the railway, which not only offers an evenly-graded route, but affords facilities for the supply of fuel to intermediate pumping stations. The line might conveniently be divided into five stages corresponding with the stations of the railway, when the distances and lifts would be as follows:—

1. From Abu Hamed to No. 9 Station, distance 29 miles, height 120 feet.
2. ,, No. 9 Station to No. 8 ,, ,, 27 ,, ,, 150 ,,
3. ,, No. 8 ,, No. 7 ,, ,, 24 ,, ,, 150 ,,
4. ,, No. 7 ,, No. 6 ,, ,, 22 ,, ,, 160 ,,
5. ,, No. 6 ,, to Nabardi ,, 28 ,, ,, 140 ,,

As the power demanded at each of these stations varies less than 10 per cent., this arrangement would permit of the same size and type of plant being employed all along the line, thus facilitating and lessening the cost of duplication and repairs. The most satisfactory and economical installation would probably be a three-throw ram pump driven by a belt from a compound condensing engine steamed by a Babcock & Wilcox tubular boiler.

Before an estimate can be made of the probable cost of such a scheme, it is necessary to consider the amount of water which would be needed by the mines. For this purpose the not too favourable example will be taken of a single mining proposition, crushing, say, 100 tons of ore per day by the wet process. Such a mine may be said to employ about 200 horse-power for all purposes other than pumping. Taking the mean efficiency of condensing and non-condensing engines as requiring the evaporation of 30 lbs. of water per indicated horse-power per hour, the amount necessary for the production of 200 horse-power per day would be, say, 15,000 gallons, of which two-thirds should be recoverable by condensation. The milling of 100 tons of ore per day would require the circulation through the boxes of 200,000 gallons of water of which 5 per cent, or 10,000 gallons per day, would be lost by absorption, and, probably, an equal amount by evaporation and waste. An additional 10,000 gallons per day for domestic and camp requirements brings the total to 35,000 gallons per day, or, say, twenty-five gallons per minute as the minimum demand. The maximum demand might reach double this amount, and it would be wise to make the nominal capacity of the plant equal to at least double the maximum demand, or 100 gallons per minute.

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* Heights above m.s.l.

The velocity of flow in so long a pipe as that proposed should not exceed 1½ feet per second, and at this speed the discharge of 100 gallons per minute requires the diameter to be 5·7 inches or, say, a 6-inch main. The greatest load at any one station is 142,560 feet length of pipe against 150 feet head, say, 150,000 feet by 150 feet, to propel which at the speed of 1½ feet per second requires, theoretically, about 13 horse-power, and an initial pressure in the main of 200 lbs. per square inch.* The engines employed should therefore each be capable of developing 20 horse-power; and the total cost of such an installation, including engines, boilers, pumps and 6-inch main, may be put down at £120,000, delivered on the ground. To this must be added the cost of erection and construction of the pipe line.

This may seem a heavy outlay for a single mining Company; but the sum named could be redeemed in 10 years, with interest at 10 per cent per annum, by an annual charge of £18,000. This is equal to 400 ozs. of gold per month, which would not be an excessive burden on a moderately productive mine crushing 100 tons a day. The example taken is the least favourable under which the proposition can be considered. Should two or more Companies combine, or should the scale of operations of a single Company be sufficiently large it will admit of more favorable figures. The course indicated at present seems to be to endeavour to meet the growing demands of the mine by action along the lines here considered, *i.e.*, to supply increasing requirements by multiplication of the present wells, then by damming the ravines, and finally by a pumping station on the Nile.

As an alternative scheme to the above there is the very feasible proposition of taking the ore for treatment to the river. Should the broad-gauge line hereafter to be considered (page 72), be laid from No. 6 Station to Om Nabardi, the ore could be transported to Abu Hamed in practically unlimited quantities, and at a reasonable cost. The present goods tariff of the Sudan Government Railway works out at 7*s.* 3*d.* per ton for the whole distance of 133 miles, and it is probable that, as most of the line is down grade, an easier freight for full trains could be arranged. Besides the advantage of an abundant water supply in the reduction works, this course would also relieve the desert establishment of the maintainance of a large number of employees at enhanced cost; for labour at the river would be cheaper and more easily maintained. Another advantage to be considered is that, after the opening of the Suakin-Berber Railway, the reduction works would be 130 miles nearer port, thus reducing freight on fuel by 25 per cent.

FUEL.

This is a question scarcely less important than that of water; for in the absence of all local supply it will be necessary to meet immediate requirements by importation. Whether or not the forests of the Southern Sudan are in a position to compete with sea-borne fuel as far north as Abu Hamed is an open question which, in the absence of all enterprise in the country, is impossible of present solution. Good wood is procurable at Abu Kuka on the White Nile, about 870 miles above Khartoum, and 1,200 miles from Abu Hamed. From Abu Kuka southward there is an abundance of timber along the river for several hundred miles. With one or two interruptions, the river is navigable the whole way to Abu Hamed, and it thus seems probable that were there a sufficient demand at the latter station timber could be floated down at a profit, and with it an abundant supply of firewood at reasonable rates. The timber on the Atbara is said to be entirely endogenous and unsuitable for fuel.

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* This main could only be employed economically up to three-quarters of the maximum capacity. For a *constant supply* of 100 gallons per minute a 7-inch main would be advisable.

It seems, therefore, that for the present the choice lies between sea-borne coal and mineral oil; and it remains to consider their relative advantages—firstly, as fuel for steam production; and, secondly, in the development of power from oil direct. The experimental trials recently made with railway locomotives in Egypt are said to have resulted in an average consumption of 32 lbs. crude petroleum as against 45 lbs. of English coal. Ignoring the other numerous advantages of liquid fuel, the saving of 30 per cent in weight here indicated is alone sufficient to make it worth attention; and if the same rates of transport were in force for both coal and petroleum, there is little doubt that liquid fuel would take first place. But, unfortunately, while coal comes under the most favoured clause in the railway freight tariff, petroleum is classed as "dangerous goods" and carried only at a greatly increased rate; so that unless some arrangement can be made with the authorities, removing this embargo, there seems little chance of the profitable employment of petroleum as a substitute for coal.

To the use of oil engines there are several objections, chief of which are the ubiquitous dust and sand. The great heat also would necessarily have a prejudicial effect on the oil itself, partly volatilizing it and leaving it in a "gummy" condition unsuited for the work required. Otherwise this type of motor might be suitable for small installations, although out of the question as a substitute for steam in all the more important plant. The chief items for consideration in a comparison of cost are their economy of water and the maintainance of steaming plant; but apart from this the respective cost of power generation on a limited scale would still appear to be in favour of oil. The consumption of oil in an average oil engine may be taken at 1 pint per hour per I.H.P., under favourable conditions, and 1½ pint per hour under a varying load; while the coal consumption per hour per I.H.P. of a condensing steam engine may be taken at 5·5 lbs. The cost of the latter at 70*s.* per ton is 2*d.*, while the cost of the oil at 9*d.* per gallon amounts to 1·7*d.*

POWER.

The fourth and fifth Cataracts of the Nile, the one below and the other above Abu Hamed, are 90 miles and 110 miles respectively from the southern boundary of the Concession, while the Great Cataract above Wady Halfa is 110 miles from the Om Nabardi Mines. From either of these an almost unlimited horse-power could be obtained; and as electrical transmission of power is in successful operation in America at distances up to 175 miles, there seems no reason why in the event of the development of the mining industry on a large scale, some portion of this enormous energy should not be utilized to meet its requirements.

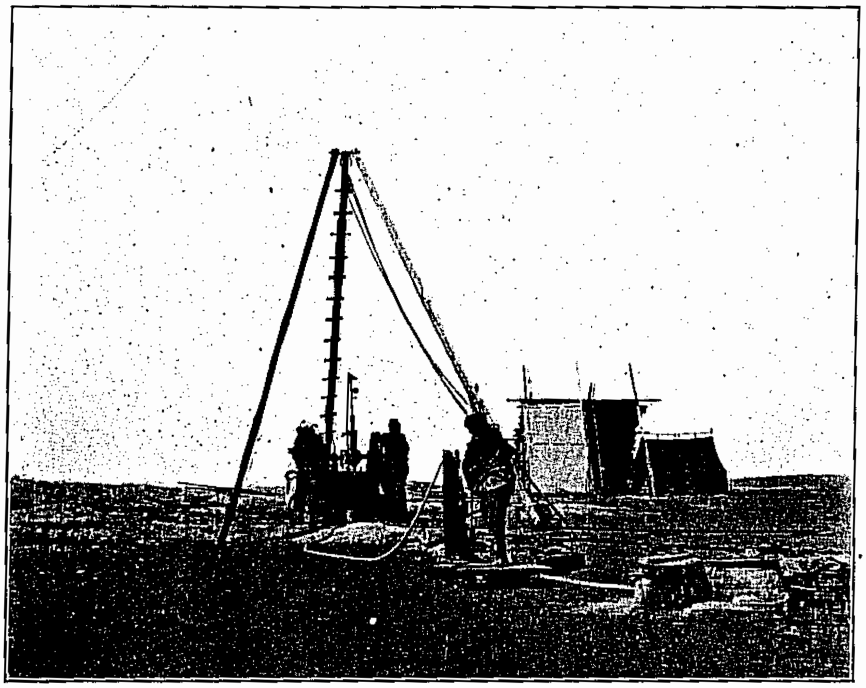
Wind Motors might be successfully employed in the desert for various purposes, and especially for pumping, where the intermittent nature of the power could be corrected by sufficient storage to regulate supply. There is usually a breeze both day and night in exposed situations, and the velocity is rarely less than ten miles per hour. A 12-feet Aeromotor has been purchased for the purpose of experiment and will be erected at Jebel Rafit in connection with the well.

Sun Motors.—It is claimed for the Solar Motor* that a 35 feet reflector machine will evaporate 200 lbs. of water per hour under a steam pressure of 150 lbs. per square inch. The nominal power of such a machine is given as 10 H.P., and in actual performance it has raised 1,400 gallons of water per minute a height of 12 feet. If this is a fair representation of its actual efficiency under normal conditions the Solar Motor is worth attention. The initial cost of such an installation (about £50 per nominal horse-power) is certainly high; but this is a small consideration as against the present cost of fuel. If there is any country in the world where the Sun Motor can be advantageously employed as a source of power it should be the Sudan, not only on account of the high price of fuel against which it competes, but by reason also of exceptional climatic conditions. There are 13 hours of sunshine in summer and 11 in winter; cloud and fog are very rare; and the relative humidity of the atmosphere is extremely low.

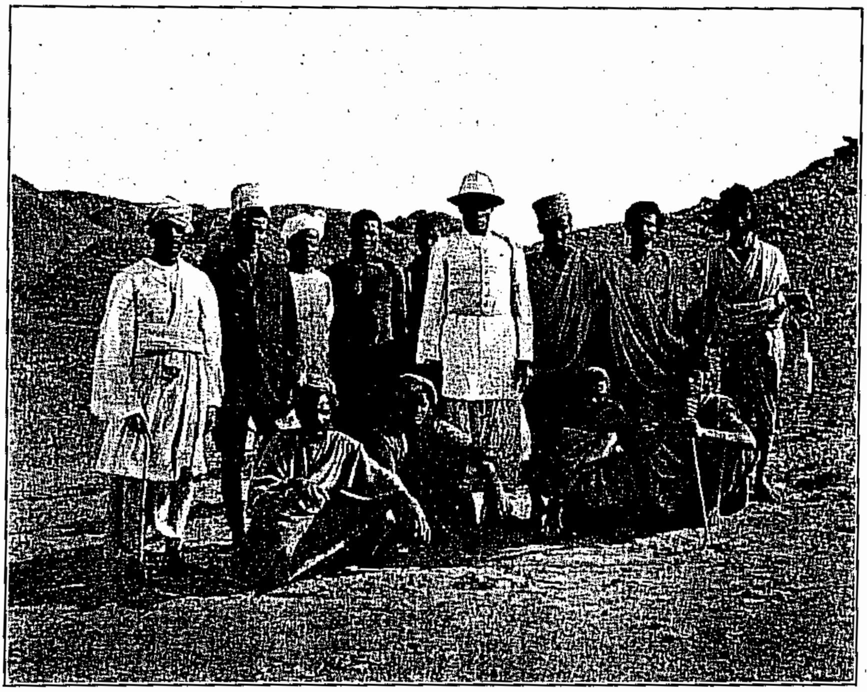
LABOUR.

In a certain sense native labour may be said to be plentiful, although at present the few wants of the labourer along the river banks are supplied by nature with such little assistance on his part that he is not accustomed to be over diligent. Peaceful settlement of the country must soon result in greatly increased population, and this for obvious reasons must be followed by increased industry among the people. In place of the Fellaheen of Egypt, the riparian dwellers of this region are a people known as Berberi. They are superior to their neighbours of the desert in many respects—chiefly in discipline and cleanliness; and their physical development renders them more suited to the labour of the mines. The domestic service of the country is largely recruited from among this race, and they are commonly employed in lower Egypt as doorkeepers, grooms, and indoor servants.

Of the desert people the Ababdi are the more useful and intelligent workers; they are bolder, too, than the Bisharin and do not object to entering the Mines, which the Bisharin are very reluctant to essay. Both are singularly adept at hauling rubbish with a bucket and a rope—an art acquired by drawing water from the wells. Generally speaking it will be found that the Bisharin are chiefly useful as camelmen and messengers; the Ababdi as surface labourers, and the Berberi as workers underground. The Ababdi, however, shows considerable aptitude for all the ordinary work of a mine, and it is believed that with a little encouragement and experience he will develop into a very capable and useful worker.



Diamond Drill at Work.



Group of E. and S. Employees.

As a labourer, pure and simple, none of the above will compare with the Sudan negro, whose splendid physical development and power of endurance render him peculiarly fit for the arduous work of the Mine. His race dwell chiefly in the south; but his adventurous spirit carries him far afield, and mining offers him a congenial occupation in which he can hoard his wealth until it is sufficient for a revel by the Nile. He is fairly amenable to discipline, and when well fed is an industrious worker; but his intellectual standard is not high, and as his childish mind is always ready to suggest some fancied slight or grievance, he requires careful handling.

All these people are paid five piastres or one shilling per day, with free rations, particulars of which will be found in the Appendix. At first there was some difficulty in obtaining the number wanted, as no similar work having been undertaken in the country before, the people were rather dubious as to the conditions and the probability of pay. These difficulties have now been overcome, and people of all races come in from north and south as far as Assuan and Berber, paying their own expenses on the road. Skilled artisans, so called, demand a higher rate of pay, and receive from 15 to 25 piastres per day,—equal to £4 10*s.* to £7 10*s.* per month. The supply is scarce, and the majority of these men are not worth the money. In face of the high pay and general inefficiency of this class, it will probably be found cheaper to import such labour either from India or Southern Europe.

TIMBER.

Practically speaking there is no timber in the country, the few acacias in the wadies being too small and scattered to receive consideration. The dom-palms might be utilized, but are too valuable to the desert dwellers and too jealously guarded to permit of their use in the mines. Great numbers of these trees are said to grow on the banks of the Atbara which joins the Nile a little above Berber, 200 miles from this Concession. They might easily be floated down to the fifth Cataract and brought from there by rail to No. 6 Station, the cost of the rail journey being 17*s.* 6*d.* per ton. Reference has already been made to the vast reserves of forest growth along the Upper Nile, and it certainly behooves any Company starting work on this Concession to obtain an experimental consignment from that district with a view to ascertaining its capabilities as a possible source of supply. It seems scarcely possible that timber could not be brought 1,200 miles *down* the river at least as cheaply as it could be carried 900 miles *up*; and in the latter case there is the additional cost of purchase at port.

The imported timber employed in Egypt is chiefly Syrian fir and Norway pine; prices at Alexandria being 1s. 2*d.* per cubic foot for the former, in planks and scantlings, and 1*s.* per cubic foot in balks; for pine 2*s.* 2*d.* per cubic foot, in planks and scantling, and for logs 2*s.* per cubic foot. Prices at Assuan are about 50 per cent. higher on the light timber and 33 per cent. higher on the heavy pine. Freight from there to Halfa by country boat about £1 per ton. The present cost of uncut timber delivered at No. 6 Station on the Concession may therefore be taken at 2*s.* per cubic foot for fir and 3*s.* 3*d.* per cubic foot for pine.

COMMUNICATION.

The only practicable means of access to the Concession at present is by the Nile route via Cairo, the distance by river and rail from Alexandria to Halfa being 912 miles. The railway ends at Assuan (550 miles from Cairo), and there is a break of gauge at Luxor, which latter will soon be obviated as the line above Luxor is at present being broadened. The fast express accomplishes the journey between Cairo and Assuan in twenty-four hours. From Assuan to Halfa communication is by boat, the Government steamers running three days a week to connect with the Express. The distance is 226 miles, and the journey up occupies about sixty hours, including stoppages, the return journey being accomplished in less than half this time. From Halfa there is a Government railway across the dessert to Abu Hamed, 230 miles. This line enters the Concession at fifty-two miles from Halfa, and traverses it for a distance of 130 miles. Goods trains are run daily, and there is a passenger service twice a week. There are nine stations along the route, six of which are in the Concession. No. 5 Station is but twenty-four miles from the Om Nabardi mines; but No. 6 Station, twenty-eight miles from the mines, is more generally used on account of the wells there, which make it more convenient for camel transport and accommodation.

A railway is now in course of construction between Berber and the Port of Suakin on the Red Sea, and is expected to be completed in two years. This will place No. 6 Station in direct communication with the sea at a distance of 500 miles, which will be of very great advantage to any Company undertaking mining operations in this Concession, as it will shorten the present line of inland communication by more than half, and provide a direct route in place of the present tortuous and broken journey up the Nile.

The present Postal Service reaches Wady Halfa, between which place and No. 6 Station postal matter for the Concession is carried weekly, in private postbags, by favour of the railway administration. There are disadvantages inseparable from this arrangement, and as soon as mining operations of a permanent character have been instituted it will be necessary to approach the postal authorities with a view to opening a branch office at No. 6. The average time of transit of the mails from No. 6 Station to London by the Brindisi route is seven days. Telegrams may be forwarded from No. 6 to any office, foreign or inland, at an inclusive charge, the rate to England being 2*s.* per word.

TRANSPORT.

As might be supposed from the conditions described, the cost of transport from Alexandria is somewhat high, and it is rendered a good deal higher than it otherwise might be by the frequent breaks *en route.* Freight on ordinary goods from Alexandria to Assouan amounts to £1 14*s.* 9*d.* per ton of 1,000 kilos.

From Assuan (Shellal) to Wady Halfa the freight per ton of 22 kantars* by Government steamer is £1 7*s.* 4*d.*, which is practically prohibitive, and for any consignment in quantity recourse must be had to native craft which can be obtained at the rate of 5 piastres per ardeb = 7*s.* 9*d.* per ton. The rail charge on heavy goods from Halfa to No. 6 Station amounts to 8*s.* 6*d.* per ton, which brings the freight charges per ton to £2 11*s.*, or—adding 4*s.* per ton for transhipment—a total charge of £2 15*s.* per ton delivered on the Concession.

As to the probable freight on goods coming in by the new route from Suakin, little can yet be said. Should the present Sudan Railway tariff be adopted on the new line, the minimum charge per ton to No. 6 Station (reckoning the distance 500 miles) would be £1 13*s.* 10*d.* It is probable, though, that over so long a lead, and taking full trains, more favourable rates for heavy goods might be secured. Another point which deserves consideration in connection with the new line is that the terminal port being in the Red Sea, Indian coal might be imported at comparatively cheaper rates and the high canal dues be thus avoided.

In connection with the question of transport a point which deserves investigation is the possible economy to be effected by the employment of a private steam-boat service on the Nile. There is no regular river service in competition with the railways, although it seems impossible to believe that this natural highway through the country does not afford a means of cheaper transport than the present rail. It may be urged that the rapid current of the river is against such method of progression; but there are, nevertheless, counteracting advantages which make it worth consideration, not the least of which is the saving in transhipment. The completion of the dam at Assuan has now rendered it possible for boats to proceed right through to Halfa, and the river is navigable for boats drawing 2½ feet of water all the way from Cairo to the Halfa Cataract. The average rapidity of the current is said to be three miles per hour; but, allowing for a current of five miles per hour, a boat capable of steaming ten knots should advance 120 miles per day, or, say, seven days for the whole journey. The journey back could be performed in half the time, and it would probably be found that each boat could make the trip on an average once in three weeks.

Local transport within the Concession is performed by camels, no other animal being at present either available or suited for the work. There being no roads, and the camel being unsuited for traction, all material has to be carried. A camel carries from 300 to 400 lbs., say ⅙th of a ton, and the cost of hire per day is from 10 to 12 piastres —*i.e.*, 2*s.* to 2*s.* 5*d.*—which equals 12*s.* to 14*s.* 6*d.* per ton per day. As twenty miles per day is a fair day's journey, the cost of transport may be said to be about 8*d.* per ton per mile. But with the scanty means of sustenance afforded by the desert routes the animal is only available for work about half the time, while its owner expects to be paid a regular hire, or at least a rate per journey which will be equivalent thereto. It is consequently found to be cheaper and more expedient to purchase and maintain sufficient camels for the ordinary routine work, and most of this is now performed by the Syndicate's own animals.

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* A Kantar = 99 lbs.; see Appendix III.

Even thus, it proves an expensive method, and if extensive operations are undertaken at any of the mines it will, above all things, be necessary to provide some more efficient and reliable means of transport. The motor-trolly first suggests itself, and there is little doubt that with the excellence of construction now attained this machine can be profitably employed to meet the immediate requirements of mines not too far distant from the rail. The motor, however, should be of the steam-driven type, burning oil of a safe flash-point; for petrol, besides labouring under almost prohibitive restrictions in transport, is too dangerous and uncertain for general employment under a desert sun. The mechanism and appliances of a petrol-driven motor, too, would be particularly liable to get out of order amidst these grinding, penetrating sands.

But motor-traction, superior as it is to the present means of transport, can never reach a high efficiency in the absence of good roads; and if road construction is undertaken it may as well be rail at once, for a light railway would probably be less expensive to construct. The cost of material for a two feet gauge line would be about £400 per mile delivered at No. 6, and it could probably be laid at a further cost of £40 per mile, as the gradients are fairly regular, and but little earthwork would be necessary.

The gauge of the present Halfa-Khartum line is 3 feet 6 inches, and although it has not been found possible to ascertain the cost of the desert portion of this railway, it would appear from such figures as are available that a line of similar construction might be made from No. 6 to Om Nabardi at a cost of £1,000 per mile. The course recommended at the present juncture is to lay down a light portable railway from No. 6 Station to the mines; this would be sufficient for all requirements while the work is in the development stage, and should the result of such development prove satisfactory, the more expensive scheme of a permanent line would deserve consideration.

APPENDIX I.

TRIGONOMETRICAL NOTES AND STATIONS.

FROM A TRIANGULATION CONDUCTED BY COL. M. G. TALBOT, *Director of Sudan Surveys.*

In the majority of cases no well known name could be found for the peak observed from. Names have therefore been borrowed from the shape of the hill or from some wady in its vicinity.

When the name given is known to the natives, the letter N. follows it. Unless otherwise mentioned each station is marked by a pillar of dry stone, seldom less than a man's height, and sometimes much more.

STATION.		LATITUDE.			LONGITUDE.			REMARKS.
		°	′	″	°	′	″	
Murat Flag	...	21	3	58·3	32	54	29·0	Erected by E. & S. Synd.
Murat East	...	21	2	41·2	32	56	36·0	On ridge SE. of Fort.
Murat West	...	21	3	9·4	32	54	7·2	Western part of same ridge.
Murat North	...	21	4	54·4	32	56	2·5	High hill enfilading wady.
Abu Biar...	N.	21	5	34·9	33	1	13·4	Low hills S. of Khor Dayob.
Dayob ...	...	21	9	52·2	32	58	54·3	Sand peak of Jebel Dayob.
Mosiai ...	...	21	8	26·2	33	4	53·7	Low hills ESE. of above.
Dila ...	...	21	13	33·0	33	0	11·8	Highest point of flat ridge.
Pyramid ...	...	21	13	18·5	33	10	14·4	Pyramid shaped hill.
Sufar ...	...	21	18	23·4	33	6	52·0	W. end of Kageretbar range.
Kageretbar	N.	21	17	52·5	33	12	8·7	E. end of " "
Kerar Berar	N.	21	11	38·5	33	26	28·2	Isolated hill E. of Gabgabba.
Nasb Hamuda	N.	21	32	6·3	33	11	49·0	Isolated hill W. of Gabgabba.
Liseini ...	...	21	22	40·2	33	37	26·7	Rounded hill S. of Bir Liseini.
Telat A[illegible]a	...	21	20	14·0	33	33	2·5	Low hill S. of wells.
Bar Tarzuga	N.	21	43	25·7	33	32	43·7	Prominent isolated hill.
Daweig ...	...	21	32	42·9	33	41	0·2	Minor hill near edge of range.
Red Hill ...	...	21	31	12·6	33	50	58·3	Watershed between wadies Kereit and Girid.
Hajar el Zarga	N.	21	52	57·0	33	57	44·8	High hill 7 miles NNW. of Bir Esmat Omar.
Shiglaiet ...	N.	21	37	0·7	33	56	2·0	1 mile E. of Bir Esmat Omar.
Esmat Omar	...	21	46	53·6	34	0	6·5	Conspicuous hill on the right bank Wady Abu Baird.
Hagareib ...	...	21	43	35·8	34	8	53·3	Prominent hill E. of Khor Abu Dom
Abu Had ...	...	21	49	21·6	34	14	34·7	High round hill E. of Khor Abu Had.
Kirmai ...	N.	21	40	56·2	34	19	28·0	Highest point near S. end of hill.
Legag ...	N.	21	56	23·8	34	11	49·5	Highest of group of rocky hills.
El Efein ...	...	21	48	34·8	34	23	20·7	Highest of a group of rounded hills.
Dune ...	...	21	56	46·1	34	21	57·5	Hill N. of track from Wady Efein.
Boundary hill	...	22	0	15·3	34	29	57·4	Low granite hill on right bank of Wady Elei.

In connection with this north-eastern boundary pillars have been erected as follows:—

I. At the intersection of lat. 22° N. and meridian of 34° 30' E. of Greenwich, in the plain of the Wady Elei, a beacon has been erected consisting of the forked trunk of a tree, the base of which has been embedded in the sand and built round with stones. From Boundary H.S. it bears about 10° E. of S., and is about 500 yards distant.

II. A dry stone pillar, due S. of I., about 3·1 miles distant. It is on the eastern slope of one of a group of blackish hills that stand up above the ruck.

III. A dry stone pillar on a saddle near the top of a low but locally conspicuous hill, about 1·1 miles due W. of I. and on the parallel of 22°.

IV. A dry stone pillar on the right bank and close to the bed of the Wady Abd-el-Ala, situated 2·8 miles due W. of I., and on the parallel of 22°.

V. A dry stone pillar of granite on one of the low hills immediately above and close to the left bank of the Wady Abd-el-Ala, on parallel of 22°.

The following have been located on or near the parallel of 22°, and are intended only as approximate guides:—

VI. Pillar of granite fragments on one of a group of small rocky mounds close to left bank of the Wady Ga. It is, perhaps, 150 to 200 yards south of the parallel of 22°.

VII. Pillar of granite fragments on a solitary rocky mound about 200 yards N. of 22nd parallel, on left bank of Wady Abu Dom.

APPENDIX II.

ANALYSES OF WATER FROM THREE OF THE MOST IMPORTANT WELLS IN THE CONCESSION.*

By Miss E. Aston, B.Sc.

The first table gives the actual amounts of the substances found; the second the approximate constitution. Quantities are in grains per gallon, and ammonia is expressed in parts per million.

TABLE I.

	Murat.	Tilat Adda.	Ad Araga.
Total solid matter, by direct evaporation ...	410·5	359·5	253·5
$Si\,O_2$	1·28	3·36	2·48
$Fe_2\,O_3 + Al_2\,O_3$	0·26	4·36	0·96
Ca	37·76	31·19	37·95
Mg	5·81	6·74	6·89
Na	61·38	63·88	21·91
K	32·08	30·41	11·18
SO_4	175·23	182·52	142;47
Cl	61·79	21·42	28·05
NO_3	1·86	1·88	trace.
	377·45	345·76	251·89
Free Ammonia	0·378	0·105	0·199
Albuminoid Ammonia	0·185	0·173	0·260

TABLE II.

Constituents.	Murat.	Tilat Adda.	Ad Araga.
Silica ... ... $Si\,O_2$ ...	1·28	3·36	2·48
Peroxide of iron and alumina, $Fe_2O_3 + Al_2O_3$ ...	0·26	4·36	0·96
Chloride of Potassium ... ... $K\,Cl$ ...	34·18	10·73	1·45
Chloride of Sodium (common salt)... $Na\,Cl$ ...	15·81	41·71	17·29
Sulphate of Soda (Glauber's salt) ... $Na_2\,SO_4$ ...	170·25	146·49	46·45
Sulphate of Magnesia (Epsom salt)... $Mg\,SO_4$ ...	28·15	32·65	33·35
Sulphate of Potassium ... ... $K_2\,SO_4$ ...	21·27	—	—
Sulphate of Lime ... . $Ca\,SO_4$ ...	59·50	81·87	120·13
Nitrate of Potassium (nitre) ... $K\,NO_3$ ...	3·03	3·36	2·26
Carbonate of Lime... ... ... $Ca\,CO_3$ ...	82·04	28·79	10·56
	415·77	353·02	234·93

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* By favour of Captain Lyons R.E., Geological Department, Cairo.

APPENDIX III.

MONEY, WEIGHTS AND MEASURES.

CURRENCY.

10 milliemes = 1 piastre tariff (P.T.) = about 2½*d.*
100 P.T. = 1 Egyptian pound = £1 0*s.* 6*d.*
£1 British = 97½ P.T.; one shilling = 4·88 P.T.

The piastre was formerly divided into 40 *paras*, but this is now almost obsolete.

WEIGHTS AND MEASURES.

The chief measure is the *Ardeb*, but its value varies considerably. In Egypt it equals 300 lbs. of grain (practically), and is divided into 3 *kantars*, each containing 36 *okes* or 100 *rotls*. A rotl = ·99 lbs.

In the Sudan the ardeb varies locally as follows :—

Khartoum : 1 ardeb = 24 rûbs of 12½ rotls = 300 rotls.
Berber : 1 ardeb = 24 rûbs of 12½ rotls = 300 rotls.
„ 1 ardeb kebir = 24 rûbs of 16 rotls = 384 rotls.
Kassala : 1 ardeb = 24 rûbs of 18 rotls = 432 rotls.
Kordofan : 1 ardeb = 60 midd of 8 rotls = 480 rotls.

The following weights are in common use, and the ratios will be found approximately correct :—

1 dirhem = ·11 ozs. av.
144 dirhems = 1 rotl = ·99 lbs. av.
2·77 rotls (or 400 dirhems) = 1 oke = 2·75 lbs.
36 okes (or 100 rotls) = 1 kantar = 99 lbs.
3 kantars (or 108 okes) = 1 ardeb = 300 lbs.

APPENDIX IV.

CURRENT PRICES OF FOODSTUFFS, &c.

		Cairo.		Assuan.		Halfa.	
		P.T.	M.	P.T.	M.	P.T.	M.
Wheat grain ...	per ardeb	75	0	90	0	110	0
Wheat flour ...	„	90	0	110	0	130	0
*Durra grain ...	„			65	0	75	0
Durra flour ...	„			78	0	90	0
Lentils	„	100	0	100	0	130	0
Rice	„	110	0	125	0	140	0
Onions	per oke	1	0		5		8
†Bahmia	„			1	5	2	0
Potatoes	„	1	0	1	5	2	0
Butter	„	14	0	12	0	15	0
Sugar	„	2	0	2	0	2	5
Coffee	„	15	0	20	0	25	0
Codfish	„	6	0	6	0	7	0
Candles	per lb.	3	0	3	5	4	0
Kerosine 125° ...	per case	20	0	25	0	30	0
Tobacco Stambouli	per oke	50	0	50	0	52	0
Tobacco Syrian ...	„	35	0	35	0	37	0
Salt	„		5		7	1	0

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* *Sorghum vulgare.* Kaffir corn. † Capsular fruit of the *Hibiscus esculentus.*

APPENDIX V.

SCALE OF NATIVE WORKMEN'S RATIONS.

EGYPT AND SUDAN SYNDICATE.

FOOD.	1 Man 1 Day.		1 Man 1 Week.		1 Man 1 Month.		10 Men 1 Mnth.		RATE.	Cost for 10 Men 1 Mnth.	
	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	ardebs.	oks.	per ardeb.	P.T.	M.
Durra flour ...	1	0	7	0	30	0	1	0	@ 90/-	90	0
Wheat flour ...	1	0	7	0	30	0	1	0	@ 120/-	120	0
Lentils... ...	0	2¼	1	0	4	6	0	16	@ 140/-	20	7·5
Rice	0	2¼	1	0	4	6	0	16	@ 140/-	20	7·5
Onions... ...	0	½	0	4	1	1½	0	4	@ 8 M.	3	0
Bahmia ...	0	½	0	4	1	1½	0	4	@ 2 P.T.	8	0
Butter	0	½	0	4	1	1½	0	4	@ 15 P.T.	60	0
Salt	0	½	0	4	1	1½	0	4	@ 1 P.T.	4	0
Meat*	0	4	1	12	7	8	0	28	@ 2½ P.T.	70	0
										396	5

	P.T.	M.
Add—Rail charges 7 kantars @ 2½ P.T.	17	5
Rail charges 1 kantar @ 6 P.T.	6	0
Camel transport 8 kantars @ 10 P.T.	80	0
Total cost of food supply for 10 men 1 month	P.T. 500	0
" " 1 man 1 month	P.T. 50	0

* When procurable.

TABLE OF EGYPTIAN SOLDIER'S DAILY RATIONS, FOR COMPARISON.

FOOD.	Dirhems.	lb.	ozs.
Bread or Biscuit	250	1	11·5
Beans	20	0	2·2
Lentils	20	0	2·2
Rice	20	0	2·2
Butter	6	0	·6
Salt	5	0	·5
Onions	5	0	·5
Vegetables...	45	0	5·0
Meat	35	0	3·8
	406	2	12·5

APPENDIX VI.

NOTES ON CAMEL TRANSPORT AND SUPPLY.

Good baggage camels are procurable at Berber at from £10 to £15 each. Only occasionally camels can be bought at Halfa or Abu Hamed, whilst Dongola is too far removed by the bend of the river to be a convenient market. The serviceable life of a camel under normal conditions corresponds very much with that of the horse.

The ordinary rate of hire is ten piastres to twelve piastres (2*s.* to 2*s.* 6*d.*) per day, including driver, and one man can attend to four camels. In desert travelling from four to six camels are required for each European of the party, and these carry food and water for all hands, cooking gear and tents. A fair camel load is from 300 to 400 lbs., but strong animals are laden more heavily, while an exceptionally strong beast will carry as much as half a ton for a short distance.

A fair food allowance for a working camel is 10 lbs. of grain (*durra*) with 10 lbs. of straw (*tibn*) per day; but he rarely gets it, and most desert camels pass their lives on the verge of starvation, browsing on such scanty herbage as they can find in the wadies, and being sustained by an occasional measure of corn when that is insufficient. They will do without water cheerfully for four days, and have sometimes to do without it for eight in the cold season. Camels on desert work should not be watered more frequently than every third day, or they will not drink deeply, and are consequently liable to suffer if the next interval happen to be a long one. A thirsty camel will drink as much as 25 gallons of water.

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